2829 $

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

28 November 2003
Re:
Application No. 08/579,395
Filing Date: 12/27/1995
Examiner: Karlsen, Ernest F.
Art Unit: 2829
William H. Swain, inventor

PETITION TO THE COMMISSIONER FOR PATENTS

Greetings,

I have met every deadline, yet this case is nearly eight (8) years old. This case was made "Special" on 26 November 2002, yet I received no written Examiner's answer to my Appeal brief to the board of Patent Appeals for nearly seven (7) months. Then on 21 November 2003 I received a fourth (4th) requirement to restrict which acts to further delay my appeal to the board.

I think I need your assistance if I am to get a well deserved Patent on method and means for building more accurate instruments for measurement and control.

William H. Swain 11-28-03

The Invention

By the Grace of God I discovered that some sensors for clamp-on direct current ammeters had a 2 to 1 or more change in signal to noise ratio (SNR) when the magnitude of an operating parameter was changed, i.e., modulated. This is the Genus from which two species are derived.

This is illustrated by Figure 5 which shows data measured using 5 inch diameter aperture clip #88. It is on page 58 of my 1995 Application.

11-26-03

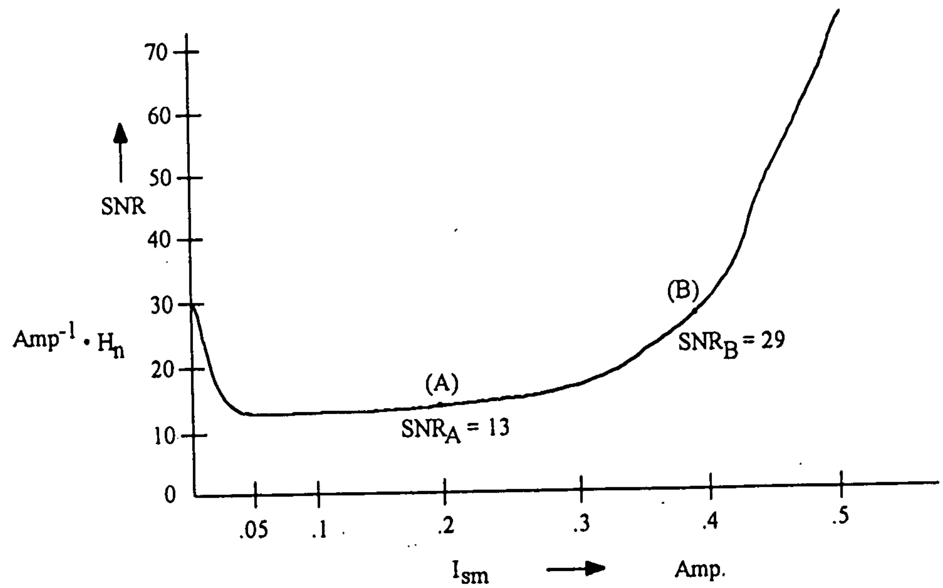

Figure 5
Signal to Noise Ratio (SNR) for Non-Uniform Field H_n
vs.
Operating Parameter I_{sm}
for
5" dia. aperture clip #88 in SN 2336

output
input

$$SNR \equiv \frac{\delta V / \delta I}{\delta V / \delta N} \Big\} \frac{\text{output}}{\text{noise}}$$

Primary Teaching

The primary teaching of my 1995 Application appears in part on page 11; line 11-15.

DISCOVERY

The inventor discovered that the output V of many Swain Meter clamps was a lot less sensitive (1/2 to 1/3 in some sensors) to a change in the intensity of a non-uniform magnetic field H_n when the magnitude of an operating parameter I_{sm} was doubled or tripled. And the sensitivity (gain) to a change in signal input current I stayed constant to within a few percent.

This Discovery is illustrated on 1995 Figure 4 which shows a normalized measurement of 5" clip #88. Figure 4 is on page 57 of my 1995 Application.

11-25-03 //

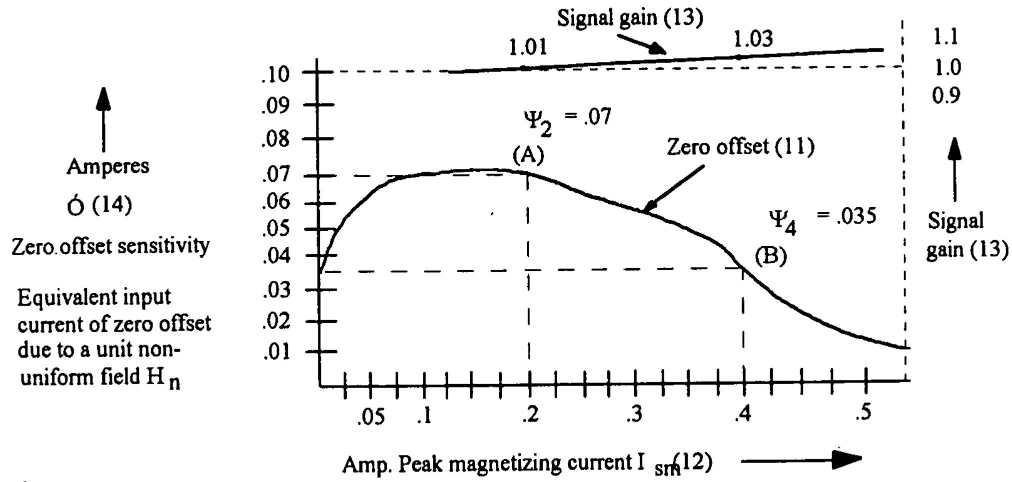

Fig. 4
Normalized Signal Gain (g) vs. I_{sm}
and
Normalized Zero Offset from H_n vs. I_{sm}
for
Five inch diameter aperture sensor #88.

This Discovery was applied so as to improve the accuracy in the presence of noise of species "Better SNR" ammeters or provide near cancellation of noise with the species "Combiner". It was found that the sensor (clip) had to have a good "Essential Characteristic". This is stated on 1995 page 11, line 16-22.

> Essential Characteristic
>
> Fig. 4 shows the approximate sensitivities for a five inch diameter aperture clip #88. This is an illustration of a sensor having the essential characteristic:
>
> Firstly, the signal gain g (13) sensitivity to signal input I (7) is constant within a few percent as an operating parameter I_{sm} (12) changes from 0.18 A to 0.5 Amp peak; and
>
> Secondly, the zero offset (11) sensitivity to a unit change in intensity of a non-linear magnetic field H_n (8) is reduced to well under half over the same range of I_{sm} (12).

Basic Concept and Requirement to Restrict

The basic concept of this invention includes a sensor based on the above primary teaching plus means to properly control the magnitude of the operating parameter. It is included in generic claims 45 plus 63-66. The basic concept is also in one form or another in each one of claims 32-62. So no one claim is patentably distinct from another. Thus the present requirement to restrict is as improper as the three (3) previous requirements[1] which were withdrawn by the Examiner.

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[1] The first three (3) requirements to restrict were in examiner's actions dated 21 February 1997, 28 January 1999, and 31 October 2001.

11-26-03

Key Events

The Primary Examiner, Mr. Ernest Karlsen, cited three sets of references which he asserted anticipated my invention. On 29 January 03 he made final rejection of all pending claims 32-66, even though I made a showing that the cited references did not teach or imply my "Basic Concept", nor did they teach my "Discovery" or "Essential Characteristic".

Some seven (7) months ago I filed notice of appeal, paid fees, and my 148 page brief[2] was filed on 14 April 2003. The Examiner's first written answer, his action of 18 November 2003, is not the expected review of my brief.

ANSWER

MPEP 1208
Page 1200-15

> The examiner should furnish the appellant with a written statement in answer to the appellant's brief within 2 months after the receipt of the brief by the examiner.
> The answer should contain a response to the allegations or arguments in the brief and should call attention to any errors in appellant's copy of the claims. Grounds of rejection not argued in the examiner's answer are usually treated as having been dropped, but may be considered by the Board if it desires to do so.

Instead, it is a fourth (4th) requirement to restrict[1].

It is similar to the others, arguing that several forms of the invention presented in my disclosure of 27 December 1995 are patentably distinct. My response to this action, dated November of 2003, will again argue that all claims and all forms of the invention of 27 December 1995 include some form of the basic concept, i.e., the "Discovery", the "Essential Characteristic", plus means to properly control the magnitude of the operating parameter, and so are not patentably distinct. The invention is one.

At the top of page 2 of 11-18-03 the Examiner alludes to issues in my brief which are petitionable. I agree that issues 6.1 - 6.1.3 (presented below) are petitionable, and herewith request the Commissioner to resolve these and withdraw them from my Appeal Brief filed 24 April 2003.

The following is a copy of page 43 of my brief[2] dated 22 April 03.

> 6 Issues Summarized
>
> 6.1 The first three issues are related. Argument is given in section 8.1, beginning on page 47.

----

[2] I enclose a copy of my brief mailed on 22 April 03.

11-26-03

6.1.1 Whether 3 year old generic method and apparatus claims 63-66, never having been examined on merit, may properly be finally rejected before examination on merit.

6.1.2 Whether claims 32-66, excepting only claim 45, can properly be finally rejected on the basis of discussion of only claim 45 when none have been examined on merit since my 148 page traverse of 6 grounds for rejection on 24 March 2000.

6.1.3 Whether the Examiner erred when he asserted, contrary to the record:

Examiner 1-29-03	By Applicant's admission in Paper No. 28 the fate of claim 45 determines the fate of all
Page 3, Line 3-4	claims so only claim 45 is discussed.

I did not so admit.

Then only issues 6.2 and 6.3 remain in the Appeal. The following are also shown on page 43 of my Brief.

6.2 Whether generic apparatus claim 45, fully viewed in the light of the disclosure, has elements not found in any one of cited references Lee, Moser et al, Hubbard, Sweeny, or Swain, Re: 35 U.S.C. 102(b).

Argument is given in section 8.45.

6.3 Whether generic method claim 66, fully viewed in the light of the disclosure, has elements not found in any one of cited references Lee, Moser et al, Hubbard, Sweeny, or Swain, Re: 35 U.S.C. 102(b).

Argument is given in section 8.66.

Action Requested

I respectfully request the Commissioner to:

6.1.1 cause an examination on merit to be made of 3 year old generic method and apparatus claims 63-66. These have never been examined on merit with results sent to me before final rejection.

6.1.2 cause an examination on merit to be made of claims 32-66, excepting only claim 45. None have been examined on merit with results sent to me since my 148 page traverse of 6 grounds for rejection of 24 March 2000.

6.1.3 Assist the Examiner to see that he erred when he asserted, contrary to the record.

Examiner 1-29-03	By Applicant's admission in Paper No. 28 the fate of claim 45 determines the fate of all
Page 3, Line 3-4	claims so only claim 45 is discussed.

I did not so admit.

6.5 Assist the Examiner to see that the present requirement to restrict should be vacated.

11-25-03

6.4 Cause my appeal of 24 April 03 to proceed.[3] This case was made special by paper No. 33 on 26 November 2002.

I enclose our check # 12807 for $130 to cover the fee for this petition.

Respectfully submitted,

William H. Swain 11/28/03

William H. Swain
Inventor

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[3] My request that my Appeal proceed is based on 35U.S.C.134 and 37CFR1.191.

MPEP 2105
Page 1200-2

35 U.S.C. 134. Appeal to the Board of Patent Appeals and Interferences.

An applicant for a patent, any of whose claims has been twice rejected, may appeal from the decision of the primary examiner to the Board of Patent Appeals and Interferences, having once paid the fee for such appeal.

37 CFR 1.191. Appeal to Board of Patent Appeals and Interferences.

(a) Every applicant for a patent or for reissue of a patent, or every owner of a patent under reexamination, any of the claims of which have been twice rejected, or who has been given a final rejection (§ 1.113), may, upon the payment of the fee set forth in § 1.17(e), appeal from the decision of the examiner to the Board of Patent Appeals and Interferences within the time allowed for response.

Claims 32-66 were finally rejected on 1-29-03.

Claims 32-66 were rejected on 9-28-02.

Claims 32-62 were rejected on 1-24-00.

I timely paid the fees and filed notice of appeal on 3/31/03. I timely paid the fee and my brief was filed on 4-24-03. The petitionable matter has been withdrawn so the Appeal can go foreword. I see no reference to a requirement to restrict, nor do I see a withdrawal of Final Rejection, as basis for withdrawing or delaying my Appeal.

Therefore, I respectfully request that the Commissioner cause my Appeal to go foreword.

11-25-03

Commissioner of Patents and Trademarks
Patent and Trademark Office
Washington, DC 20231

Attn: Board of Patent Appeals

22 April 2003
Re:
William H. Swain, inventor
Error Correction by Selective Modulation
SN 08/579,395; Filed 12/27/95; Group 2858
Primary Examiner: Mr. Ernest F. Karlsen

Summary of Brief for appeal from final rejection in the Examiner's action of 29 January 2003.

This 148 page appeal is my latest step in a 7 year effort. I seek patent protection for a new and more accurate sensor with means enabling for measurement or control.

After 3 years, generic claims 63-66 have never been examined on merit, yet are finally rejected with claims 32-62. The Examiner's basis is a discussion of only claim 45.

I appeal this on the basis that:

1) Claim element "Essential Characteristic" is not in the cited references like my 1995 disclosure and claims 45 and 66, plus the others.

- with sensitivity to a non-uniform magnetic field cut in half, as in figure 4.
- with precise definition as in page 11 and figure 5.
- with how to construct as in page 36 and figure 1.

2) The Examiner disregarded claim elements "implement" and/or "means enabling" necessary to operate the sensor so as to use the Essential Characteristic to get a whole lot more accuracy.

- by driving the magnitude of the Operating Parameter; fixed or time variable.
- by conditioning the output of a single state or multiple states after division, subtraction, and combination.
- as shown on implement diagrams figures 9 and 11, plus description on pages 32-38
- with predicted results as in basic equation i) on page 22.
- with measured result as in page 36.

It is the basic concept, i.e., the Essential Characteristic plus the implement and/or means enabling that I rely upon - that is in every claim in one form or another.

In traversing the Examiner's third requirement to restrict I repeated this, mentioning (claim 14) by way of example. The Examiner improperly construed this as admission that the fate of newer claim 45 determines the fate of all claims. He discussed only claim 45, which he improperly rejected; together with all claims 32-66. I appeal this. At least generic method claim 66 should be examined on merit.

William H. Swain
William H. Swain, Inventor
4-22-03

$135.00 enclosed; check #12558
This brief and two more copies enclosed

1) Real Party of Interest

William H. Swain is owner. The William H. Swain Co. has shop rights, and right to a share in the profits from this invention.

2) Related Appeals and Interferences

There are no other appeals at this time. There are no known interferences.

3) Status of Claims

Only claim 45 has been examined on merit in the past 3 years.

Claims 32-66 are in the case. They include generic and two species claims; method and apparatus. Some are narrow, and some broad. All are finally rejected. I appeal this.

Generic method claim 66 appears to handily overcome the ground of the Examiner's rejection.

4) Status of Amendments

No amendments have been filed subsequent to final rejection.

5) Summary of the Invention

The Examiner has said and written[1] that he did not understand this invention, so in order to make my invention more understandable I present the summary of the invention in 3 parts.

Section 5.1 presents the Basic Concept plus an explanation of the method and structure of the invention:

Section 5.2 presents excerpts from my 1995 Application. These are selected and explained so that the reader may understand Basic Concept, method, and structure of my invention. Each excerpt is tagged with the page number from which it is taken.

Section 5.3 is a reading of appealed generic claims 45 and 66 on the specification. Apparatus claim 45 is short, relying on the claim being read in the light of the disclosure. Method claim 66 has more detail, so that it is more apparent in the claim 66 itself that the cited references do not teach my invention.

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[1] For example, in the Action of 24 January 2000, paragraph 8, the Primary Examiner wrote: "The Examiner does not understand the structure or operation of the invention. It is suggested that Applicant arrange a personal or telephone interview to maybe aid in understanding." I telephoned Mr. Karlsen on 3 Feb. 2000 and provided explanations together with annotated drawings sent by fax.

4-21-03

5.1

5.1 Basic outline of the invention

This section includes copies of 2 advertisements for the MER Meter which embodies the "Better SNR" species of this invention. Figure 5.1A outlines the use and benefit of a MER Meter.

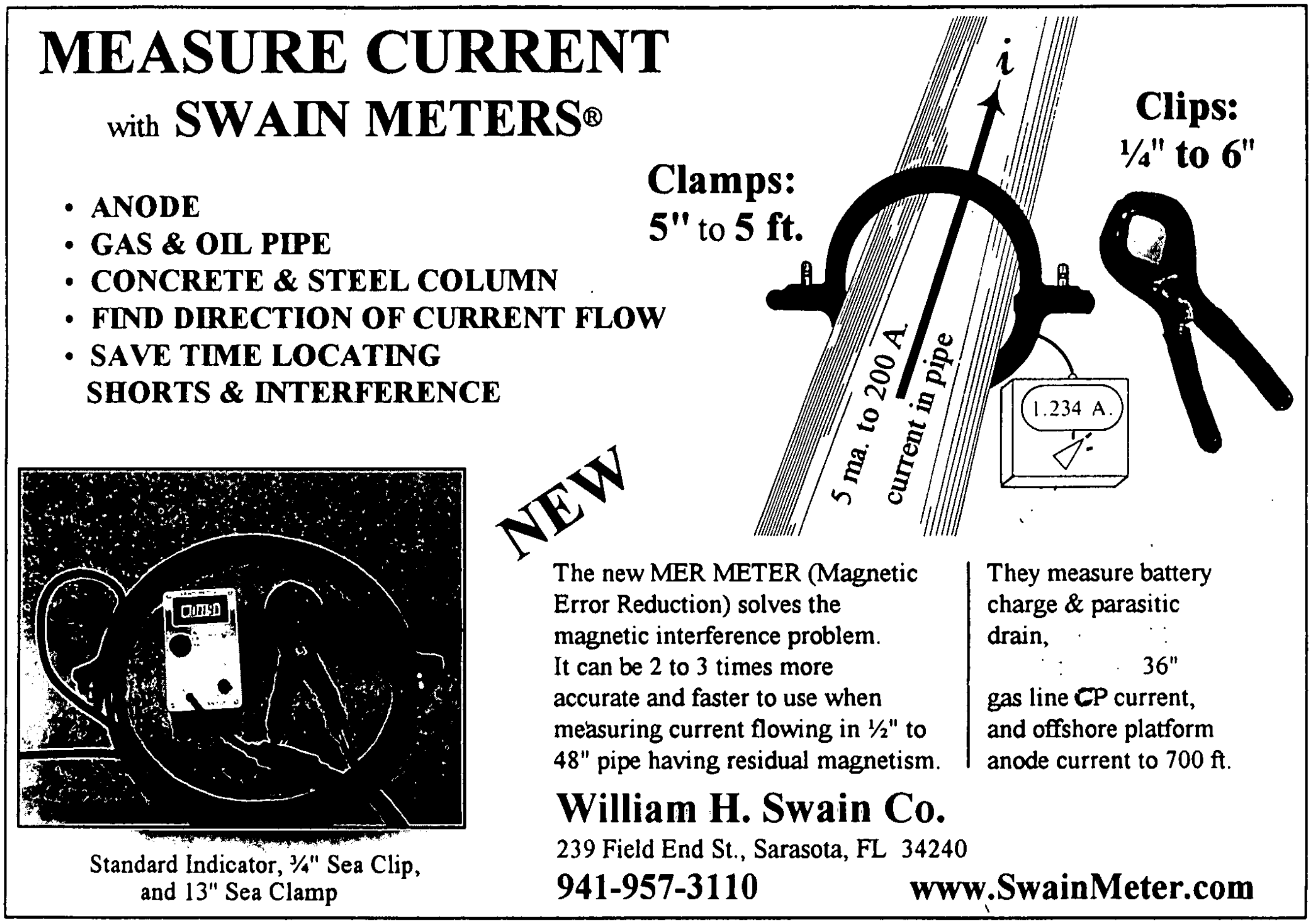


Figure 5.1 A. This 1996 advertisement appeared in *Materials Performance* magazine to let our customers know about the MER Meter - its uses and advantage. A MER Meter embodies the teachings of claims in the Better SNR species of this invention. A reference to AC is deleted.

4-18-03

The Problem

The source of the problem which this invention alleviates is illustrated in Figure 5.1B. It shows a "magnet" which represents the undesired residual permanent magnetism often induced in the wall of steel pipe at unexpected locations along the line.

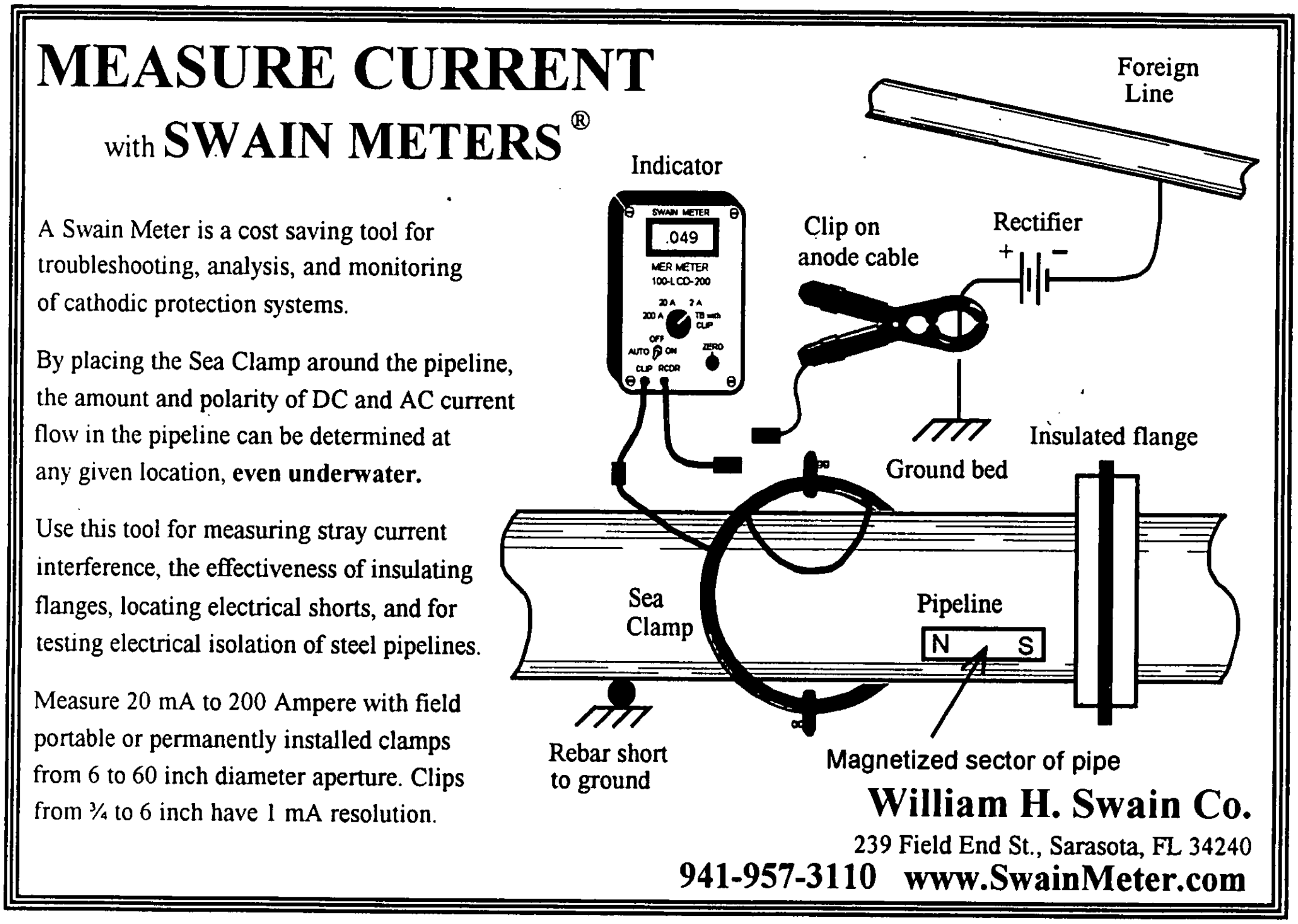


Figure 5.1B. This 2003 advertisement is here annotated with a "magnet" to show the source of the problem which this invention addresses. The "magnet" represents undesired residual permanent magnetism which is frequently induced in the wall of the steel pipe used to transport gas, oil, and water.

3-27-03

The problem is that when the clamp is near the "magnet", the magnitude of the pipe current shown on the meter is not steady. Instead, it increases or decreases if the clamp is moved along the pipe.

The location and strength of this non-uniform magnetic field; "magnet" for short, is generally not known because it is induced by welding, handling in shop or warehouse, or a magneflux type "pig" used from time to time to evaluate the quality of the pipe.

When I first saw this it was a mystery because I knew that the test current was steady. It should not matter where the clamp is placed on the test pipe. The electrical current flowing in one length of the pipe is the same as in another length.

Later, I found that the problem was zero offset caused by magnetism in the wall of the pipe. On the more sensitive current ranges, even when there was no current flowing in the pipe, the meter in Fig. 5.1.B indicated a current. With the clamp held in one place on the pipe I could adjust the zero control to make the meter read zero. But this was not useful, because the meter would read positive or negative when the clamp was moved along the pipe, or even rotated around the axis of the pipe. This zero offset error was a problem because it often limited the accuracy with which our clamp-on DC ammeters could be used to measure direct current flowing in cable and pipe. It was a long time before I was able to do anything about it, despite considerable effort.

Noise Reduction

Finally by the Grace of our Lord and Savior Jesus Christ, I learned how to make a clamp which measured current flowing in the pipe, but was relatively insensitive to permanent residual magnetism in the wall of the pipe. This invention at least alleviates the problem of zero offset error due to pipe magnetism, as represented by the "magnet" NS in the wall of the pipe in Figure 5.1 B.

In 1995 I discovered the Basic Concept. In some sensors, the sensitivity to magnetic noise was reduced without reducing the sensitivity of the sensor to the direct current flowing in the pipe when the magnitude of the operating parameter I_{sm} was increased.

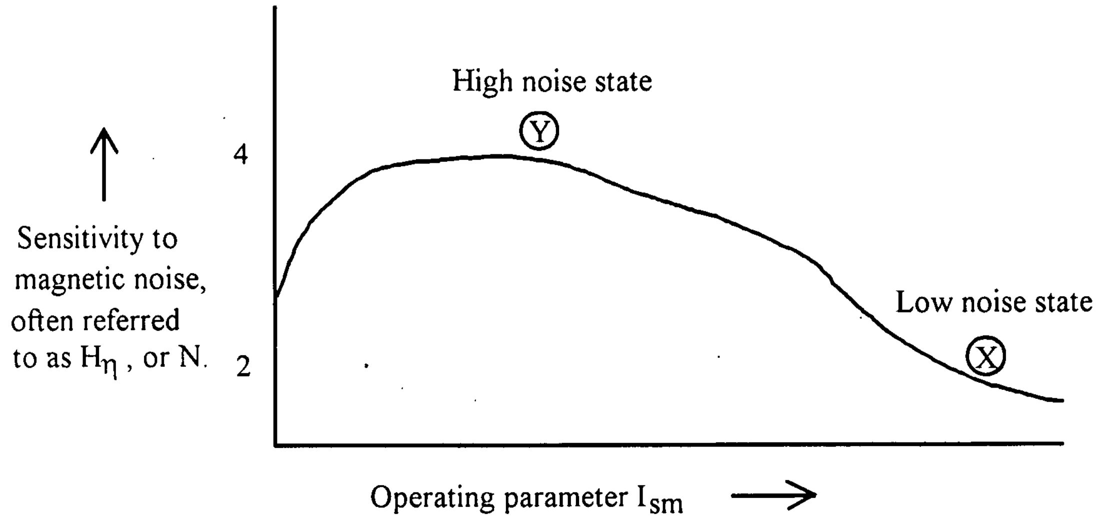
We have a way of changing SNR of the sensor itself.

I can reduce sensitivity to noise, i.e., I can reduce the zero offset error due to a nearby "magnet", without reducing the sensitivity to the current flowing in the pipe, i.e., the signal which I need to measure. In other words, I am able to improve the real accuracy of the sensor because I can change the relative sensitivity to input signal and unwanted noise. The signal to noise ratio (SNR) is improved.

AS

3-27-03

1995 Figure 4 (page 57) has the form shown below in Fig. 5.1 C.



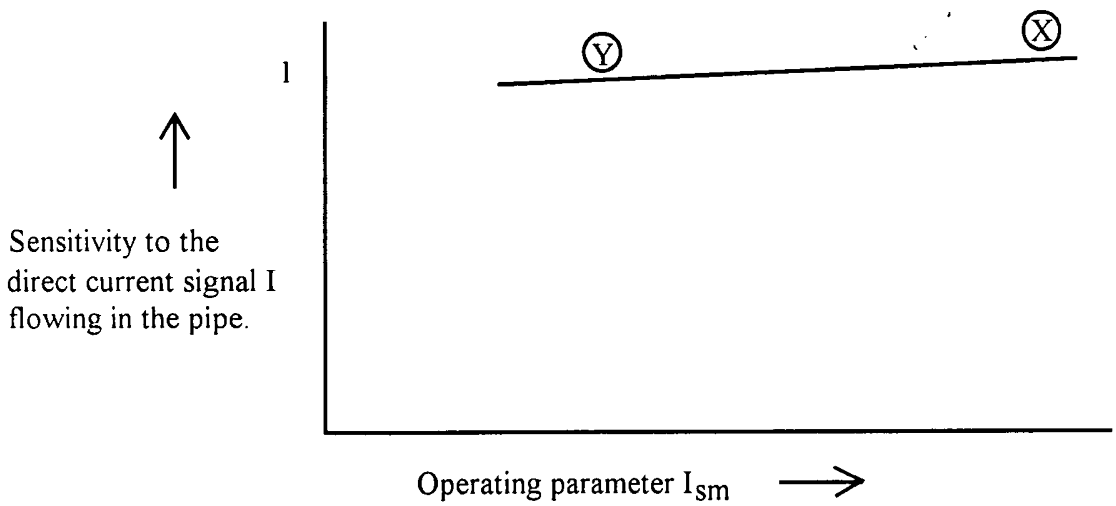


Fig 5.1 C. The sensitivity of some sensors to magnetic noise decreases while the sensitivity to pipe current signal increases slightly as operating parameter I_{sm} increases. This means that the effective signal to noise ratio is increased by increasing the magnitude of operating parameter I_{sm}.

Figure 5.1 C illustrates the "DISCOVERY" shown in my 1995 application, page 11.

DISCOVERY

The inventor discovered that the output V of many Swain Meter clamps was a lot less sensitive (1/2 to 1/3 in some sensors) to a change in the intensity of a non-uniform magnetic field H_n when the magnitude of an operating parameter I_{sm} was doubled or tripled. And the sensitivity (gain) to a change in signal input current I stayed constant to within a few percent.

4-18-03

Figure 5.1 C illustrates a sensor having a strong and useful ESSENTIAL CHARACTERISTIC. This is described in 1995, page 11.

Essential Characteristic

Fig. 4 shows the approximate sensitivities for a five inch diameter aperture clip #88. This is an illustration of a sensor having the essential characteristic:

Firstly, the signal gain g (13) sensitivity to signal input I (7) is constant within a few percent as an operating parameter I_{sm} (12) changes from 0.18 A to 0.5 Amp peak; and

Secondly, the zero offset (11) sensitivity to a unit change in intensity of a non-linear magnetic field H_n (8) is reduced to well under half over the same range of I_{sm} (12).

Since the effect of the noise is reduced to less than half but the effect of the signal stays about the same, the signal to noise ratio (SNR) of the sensor is improved by over two to one. This is done by tripling the magnitude of operating parameter I_{sm}. This is illustrated below in Figure 5.1 D.

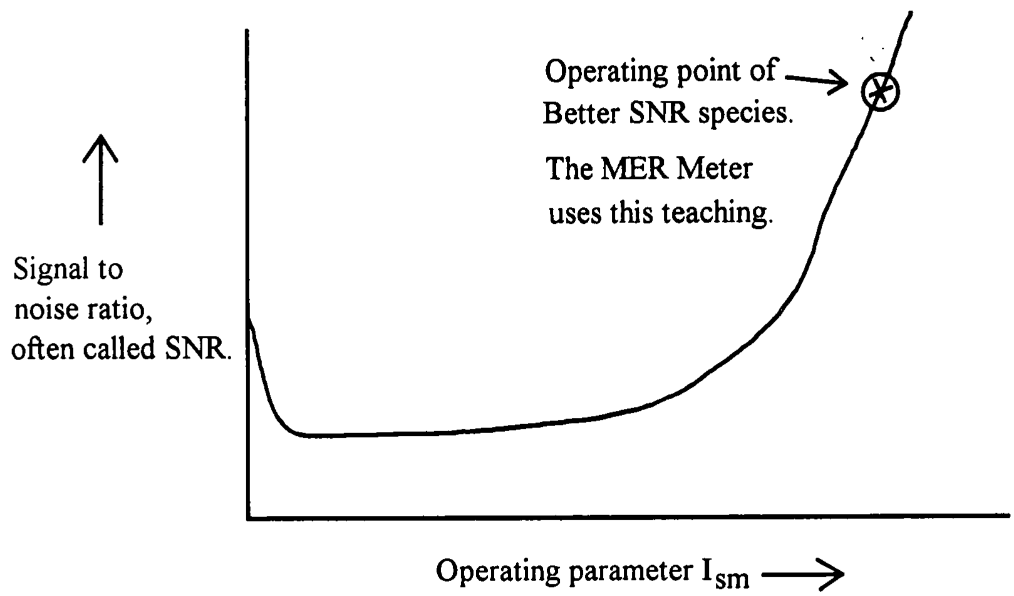
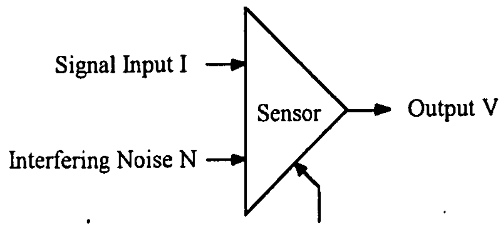


Figure 5.1 D This graph is typical of a sensor having a strong Essential Characteristic. The sensor's SNR is doubled by doubling or tripling the magnitude of the operating parameter I_{sm}. This is more precisely shown in 1995 Figure 5 on page 58. Figure 5.1 D is an example of the teaching of the claims in the Better SNR species, wherein a sensor will be operated near point X.

3-27-03

Selective Modulation

The above figure 5.1C and 5.1D show that the operating parameter I_{sm} selectively changes, i.e., modulates the sensitivity of the sensor. The sensitivity to noise N is changed a lot by I_{sm}, but the sensitivity to input signal I is only slightly changed. 1995 figure 13 is a representation of the sensor I have been describing.



1995 page 66
Figure 13

Fig. 13. General representation of a Sensor described in Eq. a) thru Eq. j).

Eq. i) is shown on 1995 page 22. Note that the operating parameter Q (I_{sm}) is not shown as an input. This is because it does not produce an output. It is a port for the orthogonal operating parameter Q which only changes, i.e., modulates the sensitivity to signal and noise.

This is not like an ordinary modulator which would change signal and noise equally. This is selective. It is an action inside the sensor which is graphed in figure 5.1C which is like figure 4 on 1995 page 57.

The sensor of this invention has outputs proportional to inputs I and N. The proportionality factor for each is changed by operating parameter Q. But not equally. Q changes the proportionality factor for N a lot more than it does for I.

This is what makes it a good tool for improving signal to noise ratio; SNR.

Noise Cancellation

The main object of this invention is to cancel out the noise, i.e., interference from nearby "magnets". The method for at least partly doing this is stated in my 1995 application, page 1, line 7, and also in page 4.

1995 page 4, line 18 says:

> A method of improving accuracy is to divide down the sensors output when it is in a high noise state, retain and later subtract this from the sensors output when it is in a low noise state so that the noise largely cancels, but a good signal remains. This may be the simplest process for combining sensor outputs.

3-27-03

A high noise state is marked as point Y on preceding figure 5.1 C. A low noise state is marked as point X. The functioning of apparatus to implement this method is outlined below. This is an illustration of the claims in the combiner species.

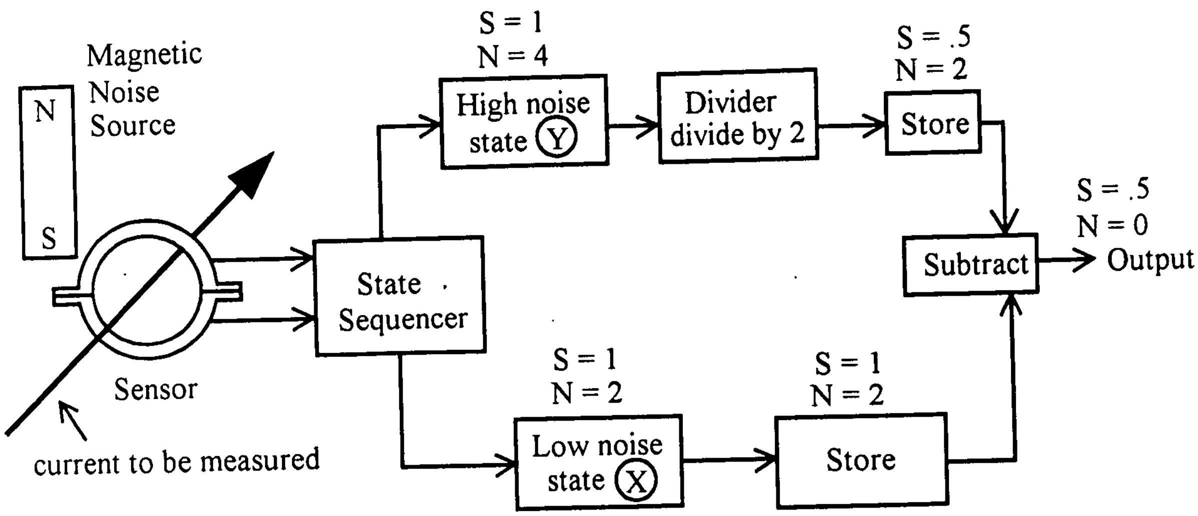


Figure 5.1 E Functional block diagram for implementing the method of 1995, page 4, line 18. Noise states Y and X are shown on Figure 5.1 C. The combiner function is provided by the subtract block. The annotations are signal and noise levels for this example. Signal S = 1 in both X and Y. The noise N = 4 in Y is divided by two in the divider. The subtracter receives N = 2 from both storage units, so the output noise is N = 0, i.e., noise is canceled. But a useful signal S = .5 remains. The result is a much improved SNR.

In figure 5.1 E the sensor is shown clamped around a conductor carrying the direct current to be measured. A zero offset error, called noise, is caused by nearby magnetic noise source NS. To largely eliminate this noise (zero offset error), I show a state switch which first connects the sensor to an indicator operated in high noise state Y, and later to another indicator operated in low noise state X.

States Y and X are marked on figure 5.1 C. For this illustration the stored noise output in Y is 4 Volts, and the stored noise output in state X is 2 Volts. The stored output due to the signal current to be measured is one Volt in both X and Y. When the output Y is divided by 2 the noise is 2 Volts, and the signal is 0.5 Volt. Subtracting this from X output of 2 Volt noise and 1 Volt signal yields a combiner output of no noise but ½ Volt signal. SNR is much improved.

3-27-03

5.2 The Basic Concepts of the Invention as found in excerpts from my 1995 Application

The Invention

PATENT APPLICATION

21 Dec 1995
Page 1

(a) Title: Error Correction by Selective Modulation

(c) Reference: U.S. Pat 3,768,011 granted to William H. Swain

(d) Summary.

This invention relates to sensors and/or implements for measurement or control.

The object of the invention is to improve accuracy by reducing error in the sensors output when in the presence of an interfering noise source.

Summary

(h) Abstract of the Disclosure.

1995 page 52
Line 1-17

The accuracy of certain sensors is greatly improved by improving their signal to noise ratio (SNR) in the presence of an interfering noise. Sensors were discovered which have a SNR which substantially changes when an operating parameter is selectively modulated to different magnitudes. Some noise can be practically eliminated. In the simplest form, the sensor is operated where it is both stable and close to its best SNR. This is usually faster and less costly, but the noise is never completely eliminated.

Often, the method involves operating the sensor in first one state and then another wherein the operating parameter has conditions where the sensor is stable, reproducible, and reliable, and wherein the SNRs are substantially different. The output of a state is combined with the output of another state in such a way that the noise cancels but a signal remains. Often the output in a state having greater noise is attenuated until it matches the noise content of another state having less noise. Then these outputs are subtracted. The difference is the more accurate error corrected output. In the ideal case, the difference has no noise output because the noise in the output from one state canceled the noise in the output of the other state.

However there is good signal in the difference, typically half as large as before subtraction, because the SNR in one state is preferably about double that in another state.

3-31-03

Simplest

"The simplest form" (abstract, line 5) is the "Better SNR" species. We sell this form as Magnetic Error Reduction, or MER Meters.

Method

"The Method..." (abstract, line 8) describes a process for making one of the "combiner" species.

Results

Page 53 Lines 3-4	This invention has first been applied to Swain Meter® type clamp-on DC ammeters. Some results are good - the benefit in SNR is between 2 and 20, generally more like 10 times.

Combiner

A method for building one of the "Combiner" species is given on page 1.

1995 page 1 Lines 8-14	The method used is usually to find or construct a sensor which has a signal to noise ratio SNR which changes a lot when its operating parameter is selectively modulated. The output of the lower noise sensor is combined with the output of the higher noise sensor so that, in the ideal case, the noise cancels, but a good signal remains. The easier way may be to take part of the output of the higher noise sensor and subtract it from the output of the lower noise sensor. Two sensors can be used, or the operating parameter of one sensor can be modulated (driven) from a higher to lower noise state.

Better SNR

The "Better SNR" species is described on lines 18-19:

Page 1 Lines 18-19	In a simpler form, SNR is substantially improved by operating at a more favorable operating parameter magnitude. Noise is not canceled, but this form can be faster and cost less.

Results are given on page 2:

Page 2, Lines 1-3	Sensors with implements using this invention have better accuracy because the SNR is generally improved by 2 to 20 times - typically ten times. This benefit is typical of Swain type clamp-on DC ammeters subject to interfering noise from non-uniform magnetic fields.

3-31-03 ✓

5.2

The Problem

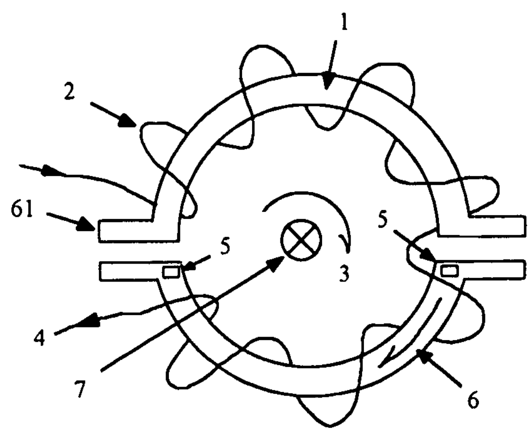
The problem addressed by this invention is described on page 9 of my 1995 application.

Page 9
Lines 5-11

The most difficult type of interference noise N to control has been that due to a strong non-uniform magnetic field H_n such as that shown in Fig. 3. A stray magnet, perhaps in a weld in a pipe, a sector of magnetized sheet metal in an automobile near the battery cable, or a magnetized fastener near the sensor can produce a considerable zero offset error Z. When the clamp-on sensor is moved from nearby to really around the conductor carrying the current to be measured, the intensity and direction of the effective non-uniform field H_n changes, and this changes the zero offset Z, and so reduces the accuracy of output V.

The Sensor

The sensor for a clamp-on direct current ammeter used to show that this invention works is shown in figure 1.



1995 page 55, figure 1

Fig. 1: A clamp-on sensor

Page 2

Fig. 1 is a functional diagram of a sensor with a split magnetic core SQ surrounding a conductor carrying a current I to be measured. The core will have a coupling sense winding N_s if it is to be used as a Swain Meter, or alternatively if it is to be used as a Hall type sensor, one or more Hall devices will replace the winding.

The meaning of the symbols in figure 1 are given on pages 9 and 10.

Input 7 is called I in the claims.

Output current 4 flowing in resistor R_s can produce V_c, which can become V in the claims.

H
12

3-31-03

Results

1995 page 9 Lines 12-17 The method and means shown herein have greatly improved accuracy by reducing noise, not only from H_n, but also, to a lesser degree, from H_u.

Operation

Fig. 1 represents a clamp-on type of non-contact sensor having a low magnetic reluctance core 1 which is split at the lips 61. These have a large cross section area to provide low magnetic reluctance all around the magnetic core path.* If it is for a Swain Meter, it will have a coupling sense winding 2. It may be called a signal translator or transducer because the input current 7 sets up an input field 3 which influences, i.e., upsets the magnetic state of the core 1 and thus causes an average current 4 to flow in coupling sense winding 2 when connected to a suitable inverter. An output voltage is available when this current 4 flows through a resistor 17 called R_s.

Page 10 Lines 1-3

Zero Offset Error

Page 10 Line 10-22 Stray magnetic fields such as those shown in Fig. 2 (H_u) and Fig. 3 (H_n) produce a zero offset error because all non-contact DC Ammeters measure the current 7 by measuring the magnetic field 3 or flux density 6 set up in the magnetic core material of the sensor by the input current 7. Some H_u or H_n gets into the core in Fig. 1 and produces a zero offset error Z.

The zero offset error Z tends to be less if the core is continuous, with no split. When the core is split at the lips 61, it is preferred that these have low magnetic reluctance, often by virtue of large surface area.

The input current 7 sets up an input field 3. It is largely uniform and constant and circular about the current carrying conductor 7. In Fig. 1, input field 3 and input flux path 6 go evenly all around the core of the clamp.

Non-Uniform Magnetic Field H_n

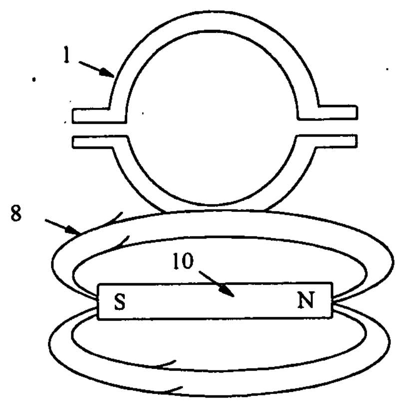
This is not true of a non-uniform field (H_n) 8 such as that due to a magnet 10 near the clamp, as shown in Fig. 3. This is also not true of a uniform field H_u 9, which may be produced by the Earth's magnetic field (H_e). This is shown in Fig. 2.

3-31-03 ✓

Noise

Undesired interference, called noise, all too often comes from permanent magnetism induced in the wall of a gas pipe carrying the current to be measured. Magnetized tools, shop handling, a weld, or an inspection tool called a magneflux pig can induce permanent magnetism in the wall of pipe transporting gas, oil, water, or chemicals. The pipe likely is cathodically protected. It likely carries a current which needs to be measured with a clamp-on direct current ammeter.

In figure 3 the magnetism induced in the pipe is represented by the magnet labeled 10. The core of the sensor is labeled 1.



1995 page 56
Figure 3

Fig. 3: A non-uniform magnetic field (H_n) 8 from a magnet acting on the core.

Noise

Page 2
Line 12-13

Fig. 3 illustrates interference from the non-uniform magnetic field H_n due to a magnet near the sensor.

Input Current

Page 10
Line 17-22

The input current 7 sets up an input field 3. It is largely uniform and constant and circular about the current carrying conductor 7. In Fig. 1, input field 3 and input flux path 6 go evenly all around the core of the clamp.

Noise

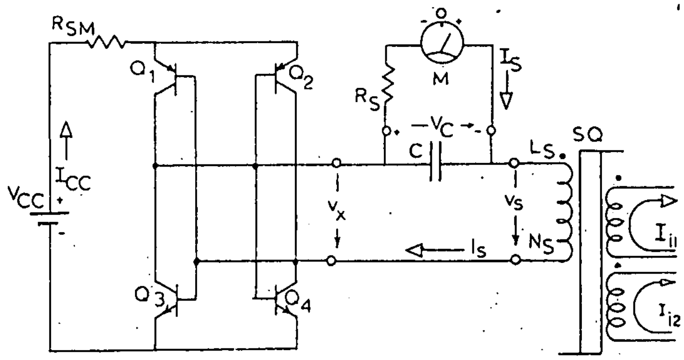
This is not true of a non-uniform field (H_n) 8 such as that due to a magnet 10 near the clamp, as shown in Fig. 3. This is also not true of a uniform field H_u 9, which may be produced by the Earth's magnetic field (H_e). This is shown in Fig. 2.

3-31-03

Implement

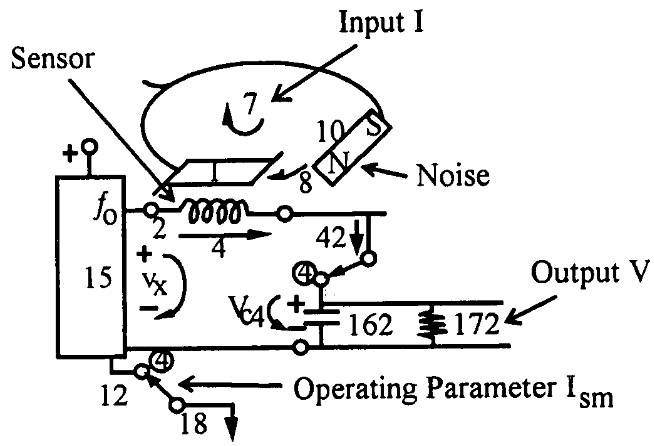
The sensor of figure 1 can be used with the simple implement of my 1970 figure 2, or with my 1995 figure 9 or figure 11. These can be simplified for use with the "Better SNR" species. This is a special case of the "combiner" species in figure 11, wherein operation is always in state Ⓑ where I_{sm} is 0.4 Amp.

1970 application
for Patent 3,768,011
Figure 2



Implement

This is figure 11
cut down to work
as a "Better SNR"
species



In the claims, the sensor output is V. This can be V_c in 1970 figure 2. In figure 11 it can be V_{c4}, or V_0, labeled 28.

The detailed description for figure 11 begins on page 35, line 14 and continues to line 3 on page 38. Additional description for I_{sm} is on page 32, line 22-23.

3-31-03 ✓

The Basic Concept

Method and Means

1995 page 4 Line 15-18 It was discovered that certain sensors have a sensitivity to an interfering noise which changes a great deal more than the sensitivity to a signal input when the magnitude of an operating parameter is changed. We call this selective modulation.

This is the basic concept used to construct both the "combiner" species and the "Better SNR" species.

Note that there are 2 parts to the basic concept:

a) the sensor, and also
b) means to properly drive the magnitude of the operating parameter.

The DISCOVERY has another wording:

DISCOVERY

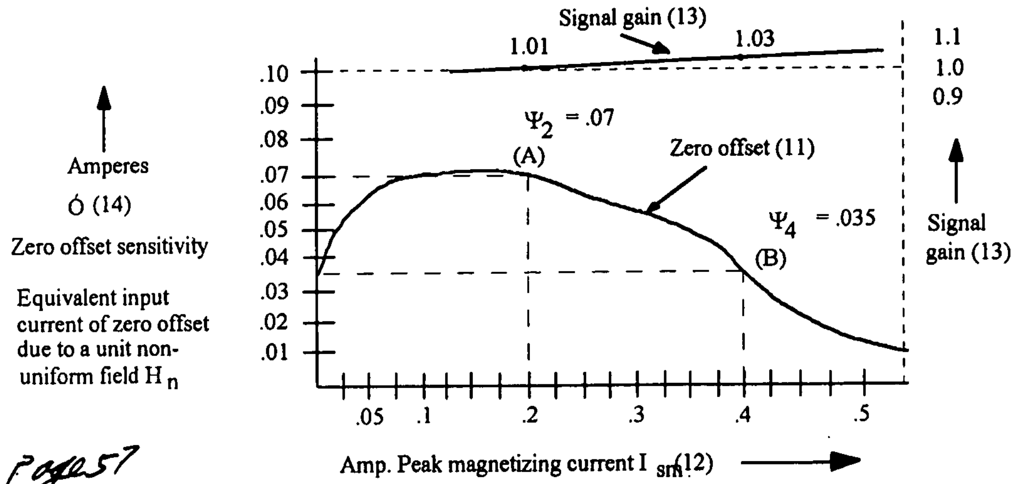
1995 page 11 Line 11-15 The inventor discovered that the output V of many Swain Meter clamps was a lot less sensitive (1/2 to 1/3 in some sensors) to a change in the intensity of a non-uniform magnetic field H_n when the magnitude of an operating parameter I_{sm} was doubled or tripled. And the sensitivity (gain) to a change in signal input current I stayed constant to within a few percent.

Note that the operating parameter I_{sm} modulates the sensor's sensitivity to the noise input H_n without significantly changing the sensitivity to signal input current I.

Note also that I_{sm} does not act as an input. If there is no noise N or signal I input, the output V of the sensor is not changed by operating parameter I_{sm}.

After making the DISCOVERY I tested 5 inch diameter aperture clip #88. The result is shown in figure 4 below.

3-31-03



1995 Page 57
Figure 4

Fig. 4

Normalized Signal Gain (g) vs. I_{sm}
and
Normalized Zero Offset from H_n vs. I_{sm}
for
Five inch diameter aperture sensor #88.

1995
Page 2
Line 14-17

Fig. 4 is a graph illustrating the essential characteristic discovered in a type of clamp used in some Swain Meters. As the operating parameter I_{sm} increases, the signal gain increases only slightly, but the normalized output zero offset due to noise, here called Ó, first increases and then decreases to half and less.

Structure

The structure of this 5" clip #88 is shown on page 12.

1995
Page 12,
line 3-14

The data in Fig. 4 shows the approximate behavior of 5" dia. aperture clip #88. It uses concepts shown in Patent 3,768,011, especially in connection with Fig. 2 and Fig. 4 therein. Clip #88 is outlined in Fig. 1 herein. The primary parts are:

A core SQ (1) having five layers of 0.725" wide-4D low reluctance steel from Magnetics Inc. of Butler, PA.,

The core is mounted on a support and arranged so that the magnetic reluctance around the full magnetic path is minimized. Care should be used to avoid forcing or bending the steel because stresses and strain may produce a poorer core.

A uniform coupling sense winding N_s (2) of about 1000 turns of #22 magnet wire. A symmetrical and balanced form is preferred. The winding resistance should be less than 5 ohms.

Half inch lips (61) which are constructed to mate well so that the magnetic reluctance all around the core is minimized.

3-31-03

The terms relating noise sensitivity Ψ, signal sensitivity g, etc. are discussed on pages 12 & 13.

1995 Page 12 Line 1-2 — Zero offset is given in terms of $\acute{O} = Z/g$, where the input current I equivalent to the zero offset Z is obtained by dividing the zero offset Z by the signal gain g. The result Ó (14) is plotted in Fig. 4.

Essential Characteristic

1995 Page 12 Line 15-24 — The essential characteristic for successful error correction by selective modulation shown in Fig. 4 for clip #88 plots - in effect - noise sensitivity Ψ times gain g against the operating parameter I_{sm}. This is from $\Psi \equiv \frac{\acute{O}}{N}$, where Ó is still the equivalent input current of a zero offset Z and N is a unit of noise, in this case, magnetic field H_n. These and other matters are discussed in more detail in the general method section. Eq. i) on page 22 states the general method.

Signal to Noise Ratio (SNR)

Signal to noise ratio SNR is the reciprocal of noise sensitivity Ψ, i.e.,

ibid

$$SNR = \frac{1}{\Psi}$$

1995 Page 13 Line 20-24 — SNR is, in a way, easier to understand, and it can help in writing claims, partly because it is basic. This will be made more apparent in the Hall device discussion. Fig. 5 is an SNR plot of the same #88 clip over the same operating parameter I_{sm} range of magnitudes as in Fig. 4. It shows SNR, which is the signal sensitivity (gain g) divided by the noise sensitivity ($g\Psi$) changing from a minimum of about 13 at about 0.07 Amp I_{sm} to over 50 as I_{sm} approaches 0.5 Amp peak.

Good Essential Characteristic

1995 Page 13 Line 1-9 — The essential characteristic necessary for good error correction by selective modulation can be measured and presented in several ways, but that shown in Fig. 5 - the plot of SNR vs. Operating Parameter is now considered the most basic. A good characteristic such as that in Fig. 5 has a substantial change in SNR - two to one or more - over a practical range of the condition of the operating parameter. It is not necessary that the gain g be nearly constant. Good correction can be had when the gain g changes 40% as the operating parameter Q is driven from one condition to another.

Figure 5 has the form of figure 4 turned upside down.

4-21-03 ✓

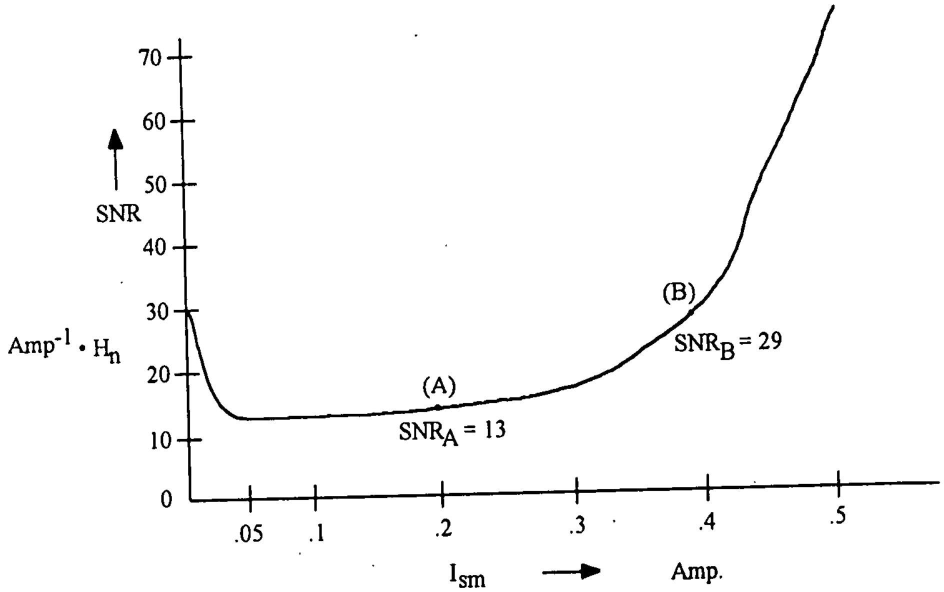


Figure 5
Signal to Noise Ratio (SNR) for Non-Uniform Field H_n
vs.
Operating Parameter I_{sm}
for
5" dia. aperture clip #88 in SN 2336

$$SNR \equiv \frac{\overset{\text{output}}{\delta V} / \overset{\text{input}}{\delta I}}{\delta V / \delta N} \Big\} \frac{\text{output}}{\text{noise}}$$

$$= \frac{\text{gain}}{\text{gain} \cdot \frac{\delta \acute{O}}{\delta N}} \leftarrow \frac{Z}{g} = \text{equivalent input offset I per unit non-uniform field } H_n$$

1995 page 58
Figure 5

1995 Page 2
Line 18-19

Fig. 5 is a graph illustrating the essential characteristic in terms of signal to noise ratio SNR for 5" diameter aperture clip #88.

SNR Defined

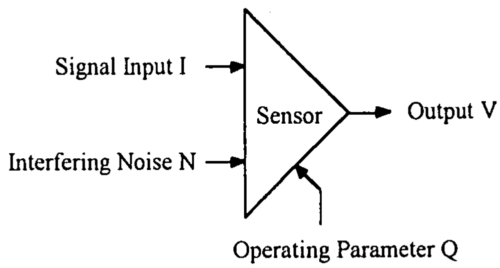
Figure 5 presents the Essential Characteristic of the Basic Concept together with a definition of signal to noise ratio - SNR.

SNR is the signal sensitivity - output per unit input, divided by the noise sensitivity - output per unit noise (H_n).

3-31-03

Orthogonal

Note that there is no output due to operating parameter I_{sm}. It is orthogonal. I_{sm} primarily modulates the noise sensitivity. This concept can be seen in figure 13.



1995 page 66
Figure 13

Fig. 13. General representation of a Sensor described in Eq. a) thru Eq. j).

In figure 13 the inputs are I and N. The output V responds linearly to the inputs. The relationship is:

$$V = gI + \Psi N, \text{ where}$$

g is the sensitivity of the output V to input I, i.e.,

$$g = \frac{\delta V}{\delta I}, \text{ also}$$

Ψ is the sensitivity of the output V to interfering noise N, i.e.,

$$\Psi = \frac{\delta V}{\delta N}.$$

g and Ψ are modulators, or multipliers.

The magnitude Q of the operating parameter determines the magnitude of both g and Ψ.

At point (A) in figure 4, Q (I_{sm}) = 0.2 Amp, g = 1.01, and Ψ = .07, but at point (B) the magnitude Q (I_{sm}) = 0.4 Amp, g = 1.03, and Ψ has dropped to half, i.e., Ψ = .035. This is selective modulation. The Essential Characteristic is good.

Note that g and Ψ have been changed by the magnitude Q (I_{sm}) of the Operating Parameter. But there is no direct part of Q in the output V.

This action is orthogonal. The magnitude of Q (I_{sm}) changes the magnitudes of g and Ψ, but Q does directly not add to or subtract from the output V. Equation i) on the next page has a similar form.

The basic concept is used as a tool to build a clamp-on DC ammeter - and likely other devices - having better accuracy because overall SNR is better. Given a sensor having the Essential Characteristic and means enabling its operation by setting or changing the magnitude Q of the

4-21-03

Operating Parameter from I_{sm} = 0.2 A to I_{sm} = 0.4 A I can make a more accurate instrument because noise is reduced.

Combiner

A method for making a combiner species was given in 1995 claim 1; since cancelled.

Claim 1

1995 Claim 1 I Claim:

A method for improving accuracy in an implement for measurement or control of a physical quantity by canceling out error due to an interfering noise N so as to provide an error corrected output V_c, sensitive to a signal input I, which includes the steps:

find or construct a sensor with an output V which has a signal to noise ratio SNR which changes substantially when the condition of an operating parameter Q is selectively modulated,

provide means whereby said output V of the said sensor in a higher said SNR state due to a condition of said operating parameter Q is combined with said output V of said sensor in a lower said SNR state due to a different said condition of said operating parameter Q, and

adjust said combined so that the said noise N mostly cancels but said sensor continues to have a good gain for said signal input I.

General Method

A general method is derived and applied on 1995 pages 13 to 26. To use this method you need to build a sensor and then measure its Essential Characteristic to find out if it is like figure 4. Then you can locate points (A) and (B), and make the design. Eq i) on page 22 is more basic than most.

$$\boxed{\text{Eq. i)}\quad V_c = (g_B - \frac{g_A}{\eta})I + (g_B\Psi_B - \frac{g_A\Psi_A}{\eta})N.}$$

This is a more basic equation, i.e., a general method..

The second term is the error due to noise which we want to cancel. Then the coefficient of noise N will be zero if:

$$g_B\Psi_B = \frac{g_A\Psi_A}{\eta}, \text{ or}$$

$$\frac{1}{\eta} = \frac{g_B}{g_A}\frac{\Psi_B}{\Psi_A}, \text{ and remembering that } \frac{\Psi_B}{\Psi_A} \equiv \beta, \text{ we have}$$

1995 page 22
Line 5-14

$$\text{Eq. j)}\quad \frac{1}{\eta} = \frac{g_B}{g_A}\beta, \quad \text{or} \quad \eta = \frac{g_A}{\beta g_B}.$$

eq i), etc. So the requirement for noise N cancellation is that the sensor be designed so that the divisor

4-10-03

factor η is set according to Eq. j), using measured or calibrated characteristics of the sensor as shown in Fig. 6.

Note that if $g_A = g_B$; $\eta = \frac{1}{\beta}$; or $\eta\beta \doteq 1$ is close to the error cancelation requirement.

Page 17 shows the signal and noise inputs as I and N. Page 21, line 13 shows that the error corrected output is V_C.

Equation j) defines η in terms of β. β is defined on page 20, line 20 as the ratio of the lesser noise sensitivity Ψ_B to the greater noise sensitivity Ψ_A. For a practical instrument we want β = 0.5, per page 17, line 24.

Signal gains g_A and g_B are also defined on page 17, line 23. Preferably, they are both about 1.0.

In eq i), when well adjusted, the coefficient of the noise goes to zero. When $g_A = g_B = 1$, the output Vc is:

$$V_C = \frac{I}{2}$$

This is shown on page 23, line 5. This works. I built 2 models like figure 9 and figure 11. When the adjustments are right on target the noise cancels, and a good signal remains.

The disadvantage of this "combiner" species is that the implement is fairly complex, and the adjustment tends to be right for only a narrow set of conditions. A more typical result is a reduction of the noise output by a factor of 5 or 10.

"Better SNR"

The implement for the "Better SNR" species is a lot simpler. And the "Better SNR" species usually gives a noise reduction of 2 or 3 to one. To design a "Better SNR" you need the equivalent of figure 4 for the sensor at hand. Then you can locate Point (B), and proceed.

The "Better SNR" species is a special case of the "combiner" species. In eq i) g_A goes to zero because there is no high noise state A. The operating parameter I_{sm} may be set at 0.4 Amp to put the sensor in the low noise state B. For 5" clip #88 the SNR is then 29 under the conditions of figure 5. This is put briefly on 1995 page 52.

1995 page 52 Line 5-7 — In the simplest form, the sensor is operated where it is both stable and close to its best SNR. This is usually faster and less costly, but the noise is never completely eliminated.

We build these "Better SNR" species and call them MER Meters. They work well in a wide variety of circumstances.

4-10-03

5.3.45

5.3.45 Reading of Generic Claim 45 on the Specification and Drawings.

Generic Claim 45 is for both the "Combiner" species and the "Better SNR" species. The elements are underlined, and numbered on the right.

	Element #
Claim 45	
An improved Sensor	1
having an output V responsive to a physical quantity I, and also	2, 3
responsive to an undesired interference N,	4
the ratio of	5
the said responsiveness of the said output V to said physical quantity I	
in relation to	
the said responsiveness of said output V to said interference N	
being defined as the Sensor's signal to noise ratio SNR,	6
which can be stated in symbolic form:	

$$\mathrm{SNR} \equiv \frac{\delta V / \delta I}{\delta V / \delta N}\text{, where}$$

δV is a change in said output V,	
δI is a change in said physical quantity I, and	
δN is a change in said interference N; and also	
said Sensor is constructed to have the Essential Characteristic that the	7
said signal to noise ratio SNR is	
substantially altered by Selective Modulation of an Operating Parameter Q, and	8, 9, 10
means enabling said Sensor to substantially increase said SNR in at least one of:	11, 12
a Machine, or independently.	13

Following are sections of the disclosure which define and interrelate the elements of claim 45 in an understandable manner.

Sensor (element 1) and output (element 2) have antecedent on page 1, line 6 of my 1995 Application.

4-18-03 ✓

5.3,45

PATENT APPLICATION

21 Dec 1995 — (a) Title: Error Correction by Selective Modulation

Page 1

(c) Reference: U.S. Pat 3,768,011 granted to William H. Swain

(d) Summary.

This invention relates to sensors and/or implements for measurement or control.

Objective

The object of the invention is to improve accuracy by reducing error in the sensors output when in the presence of an interfering noise source.

Method

1995 page 1
Lines 8-14

The method used is usually to find or construct a sensor which has a signal to noise ratio SNR which changes a lot when its operating parameter is selectively modulated. The output of the lower noise sensor is combined with the output of the higher noise sensor so that, in the ideal case, the noise cancels, but a good signal remains. The easier way may be to take part of the output of the higher noise sensor and subtract it from the output of the lower noise sensor. Two sensors can be used, or the operating parameter of one sensor can be modulated (driven) from a higher to lower noise state.

SNR Defined

Elements physical quantity I (element 3) and interference N (element 4) are implied in "Signal to Noise Ratio" on line 8. They are more definite in the formula which is part of the caption of figure 5:

output

input

$$SNR \equiv \frac{\delta V / \delta I}{\delta V / \delta N} \Big\} \frac{\text{output}}{\text{noise}}$$

Part of figure 5, 1995 page 58

Element Definitions

Output V (element 2), physical quantity I (element 3), and N (element 4) have antecedent on page 8 and 9. Output V has antecedent on lines 9 and 11 of page 8. Output V also has antecedent as item 28 (V_0) on figure 9. Physical quantity I has antecedent on line 3 and 11 of page 8. Undesired interference N (element 4) has antecedent on line 11 and 12 on page 8.

4-17-03 JJ

5.3.45

Introduction

1995 Page 8 Swain Meter type clamp-on DC ammeters have gained wide acceptance because they are generally sensitive and accurate and available in a variety of forms for measuring 10 mA to 500 Amp. direct current with sensors from ¼" to 5 feet in diameter. A clamp-on type sensor is shown

Line 5 in Fig. 1 herein.

A sensor plus implement combination can be constructed using the concepts of U.S. Patent 3,768,011 to serve as a non-contact ammeter. In Fig. 2 therein, resistor R_S can be made quite small - 100 ohms or less, and capacitor C quite large - 1000 micro farad or more.* The output voltage V_c across capacitor C and resistor R_S will henceforth be written simply as V, and in some places, assumes a more general meaning. More gain is assumed to be available if needed.**

The output voltage V is sensitive to an input signal current I, and also to an interfering noise N which causes an output zero offset Z. Fig. 13 represents a sensor with functional symbols. An equation can be written to relate these:

The Problem

The need for an improved sensor (element 1) is shown on lines 5 to 11 of page 9.

1995 Page 9 We have got 1% type control over the gain g, and also good control over zero offset Z due to the magnetic field of the earth H_e. On a ¼" clip this can be as low as 0 ± 1 ma. peak equivalent

Line input current Ó in response to a full vertical north-south spin in the earth's field H_e. We call the earth field uniform, H_u as shown in Fig. 2 herein.

5 The most difficult type of interference noise N to control has been that due to a strong non-uniform magnetic field H_n such as that shown in Fig. 3. A stray magnet, perhaps in a weld in a pipe, a sector of magnetized sheet metal in an automobile near the battery cable, or a magnetized fastener near the sensor can produce a considerable zero offset error Z. When the clamp-on sensor is moved from nearby to really around the conductor carrying the current to be measured,

10 the intensity and direction of the effective non-uniform field H_n changes, and this changes the zero offset Z, and so reduces the accuracy of output V.

Ratio (element 5) has antecedent in the DISCOVERY phrase "a lot less sensitive".

Element Antecedent in DISCOVERY

DISCOVERY

1995 The inventor discovered that the output V of many Swain Meter clamps was a lot less sensitive

Page 11 (1/2 to 1/3 in some sensors) to a change in the intensity of a non-uniform magnetic field H_n when

4-17-03

5.3.45

the magnitude of an operating parameter I_{sm} was doubled or tripled. And the <u>sensitivity (gain)</u> to a change in signal <u>input current I</u> stayed constant to within a few percent.

Sensor (element 1) in DISCOVERY is a "Swain Meter Clamp", a device for measuring direct current.

In claim 45 "responsive" is synonymous with "sensitive".

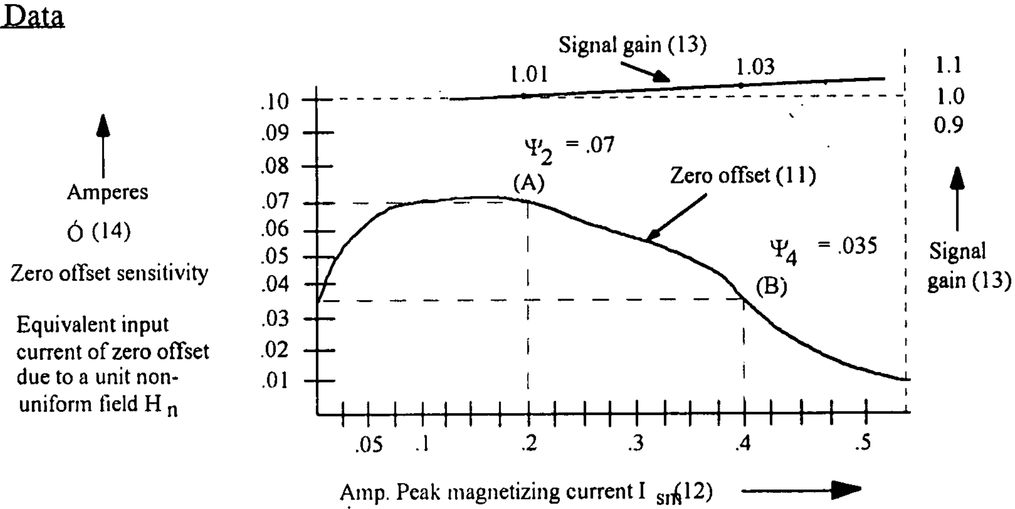
Output V (element 2) is the "output V" in DISCOVERY.

Physical quantity I (element 3) is the "signal input current I" in DISCOVERY.

Interference N (element 4) is the "non-uniform magnetic field H_n" in DISCOVERY.

The experimental data leading to DISCOVERY are plotted in figure 4:

<u>Graph of Test Data</u>



1995 page 57
Figure 4

Fig. 4

Normalized Signal Gain (g) vs. I_{sm}
and
Normalized Zero Offset from H_n vs. I_{sm}
for
Five inch diameter aperture sensor #88.

<u>Definitions</u>

Gain g and Ψ are defined on lines 15 and 16 of page 5.

1995 Page 5
Line 13-16

The <u>General Method and Mathematical Relationship</u> section considers the theory and uses Figs. 6, 7, and 8 to describe a hypothetical and generalized sensor later used to illustrate an application

4-17-03

5.3.45

of the theory. The sensor's output V has a sensitivity to an input I, called gain g. The sensor also is sensitive to a noise N, and this is called Ψ. The inverse of Ψ is the SNR. All are defined and inter-related.

Selective Modulation and Operating Parameter

Selective modulation (element 9) is illustrated in figure 4 above. Changing the magnitude of the operating parameter (element 10) from 0.2 Amp to 0.4 Amp modulated the signal sensitivity (gain) by only 2%. But in contrast, the responsiveness (sensitivity) to a non-uniform magnetic field noise H_n changed from $\Psi_2 = .07$ to $\Psi_4 = .035$.

Selective modulation (9) changed the noise (4) twice as much as the signal (2). Signal to noise ratio - element SNR (6) is defined in several parts of my 1995 specification. One is:

Page 13 Line 1 SNR, which is the signal sensitivity (gain g) divided by the noise sensitivity ($g\Psi$)...

SNR (element 6) is also defined in the caption of figure 5.

Orthogonal

Selective Modulation is orthogonal in the sense that the output V is the sum of the signal I multiplied by the gain g plus the noise N multiplied by noise sensitivity Y. Thus:

$$V = gI + \Psi N.$$

The magnitude of the operating parameter does not add to or subtract from the output V. It multiplies the values of g and Ψ; selectively, i.e., g changes little, but Ψ changes a lot with a change in I_{sm}.

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5.3.45

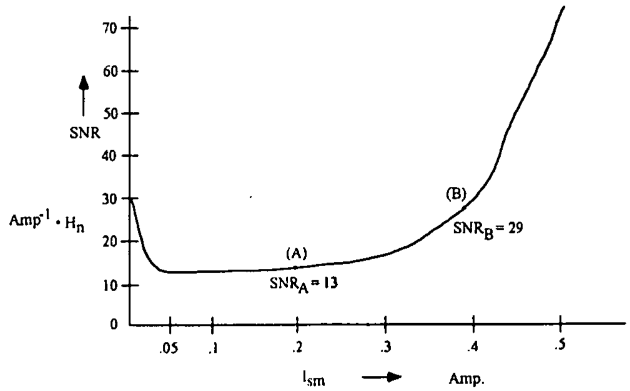


Figure 5
Signal to Noise Ratio (SNR) for Non-Uniform Field H_n
vs.
Operating Parameter I_{sm}
for
5" dia. aperture clip #88 in SN 2336

output
input

$$SNR = \frac{\delta V / \delta I}{\delta V / \delta N} \} \frac{\text{output}}{\text{noise}}$$

$$= \frac{\text{gain}}{\text{gain} \cdot \frac{\delta O}{\delta N}} \leftarrow \frac{Z}{g} = \text{equivalent input offset I per unit non-uniform field } H_n$$

Figure 5, 1995 page 58

Essential Characteristic

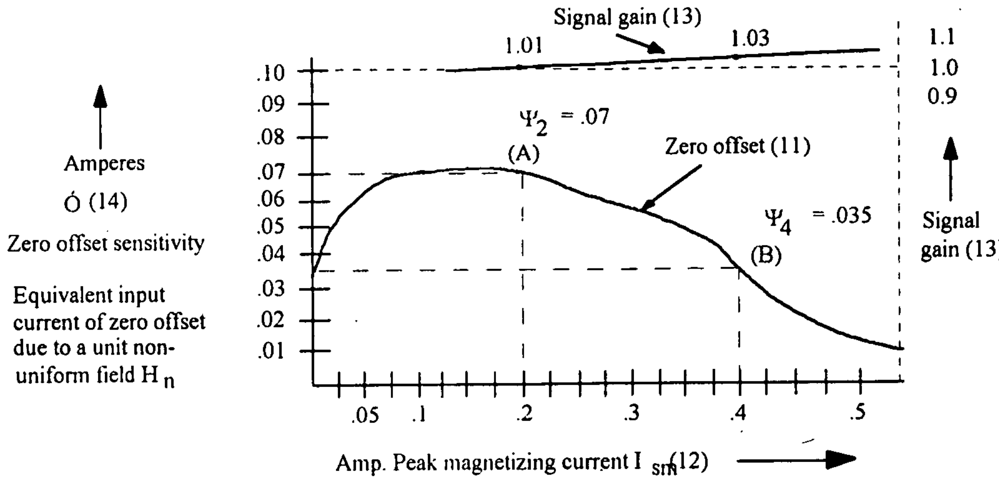
Essential characteristic (element 7) is defined in several places. It appears twice on page 11. Figure 5 is an example.

> Essential Characteristic
>
> Fig. 4 shows the approximate sensitivities for a five inch diameter aperture clip #88. This is an illustration of a sensor having the essential characteristic:
>
> Firstly, the signal gain g (13) sensitivity to signal input I (7) is constant within a few percent as an operating parameter I_{sm} (12) changes from 0.18 A to 0.5 Amp peak; and
>
> Secondly, the zero offset (11) sensitivity to a unit change in intensity of a non-linear magnitude field H_n (8) is reduced to well under half over the same range of I_{sm} (12).

1995
Page 11

The measured data is graphed on figure 4.

4-17-03



1995 page 57
Figure 4

Fig. 4

Normalized Signal Gain (g) vs. I_{sm}
and
Normalized Zero Offset from H_n vs. I_{sm}
for
Five inch diameter aperture sensor #88.

The Essential Characteristic (element 7) for successful error correction by selective modulation is stated on pages 11 and 12.

1995 Page 12
Line 15-19

The essential characteristic for successful error correction by selective modulation shown in Fig. 4 for clip #88 plots - in effect - noise sensitivity Ψ' times gain g against the operating parameter I_{sm}. This is from $\Psi \equiv \frac{Ó}{N}$, where Ó is still the equivalent input current of a zero offset Z and N is a unit of noise, in this case, magnetic field H_n. These and other matters are discussed in more detail in the general method section. Eq. i) on page 42 states the general method.

Magnitude of the Essential Characteristic

This points to a two to one ratio of noise sensitivity (Ψ_2 = .07 to Ψ_4 = .035) like figure 4, all while the signal gain is relatively constant.

Sensor Construction

The Essential Characteristic is a result of the construction of the sensor. The construction of 5" clip #88 is given on page 36:

1995 page 36
Line 1-15

general form (see Fig. 1) as clips sold today. The steel core* 1 has 5 layers of 0.725" wide, 4 mil thick type D steel tape from Magnetics, Inc. in Butler, Pa. The clip's coupling sense coil 2 has about 1000 turns of #22 magnet wire with a resistance of 3 or 4 ohms. At point A on Fig. 4 the

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peak magnetization current 12 is about 0.2 A, and at point B it is about 0.4 A. The ratio of the zero offset error responses (ß in Eq. 5) is about 0.5.

Substantially Altered

Substantially altered (element 8) is shown in figure 5, which is the data plotted in figure 4 reformatted to show SNR. The relationship is:

$$SNR = \frac{1}{\Psi}.$$

This appears on page 5, line 16.

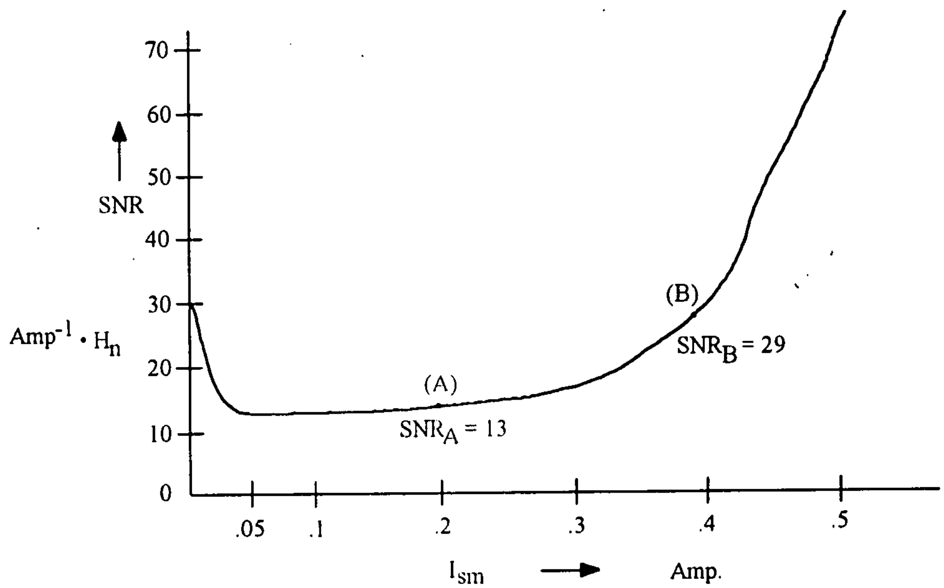

Figure 5
Signal to Noise Ratio (SNR) for Non-Uniform Field H_n
vs.
Operating Parameter I_{sm}
for
5" dia. aperture clip #88 in SN 2336

$$SNR \equiv \frac{\overset{\text{output}}{\delta V} / \underset{\text{input}}{\delta I}}{\delta V / \delta N} \Big\} \frac{\text{output}}{\text{noise}}$$

$$= \frac{\text{gain}}{\text{gain} \cdot \frac{\delta O}{\delta N}} \leftarrow \frac{Z}{g} = \text{equivalent input offset I per unit non-uniform field } H_n$$

1995 page 58
Figure 5

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SNR is substantially altered (element 8). SNR at point (A) is 13, but at point (B) it is 29. This is the two to one change for a strong or useful Essential Characteristic (element 7).

To do this the operating parameter Q (element 10) - in figure 4 and 5 Q is I_{sm} - is changed from 0.2 to 0.4 Amp in machine (element 13) SN 2336.

Means Enabling

Means enabling (element 11) is constructed to drive the magnitude of operating parameter Q so that the sensor is operated in a region where there is a substantial change in SNR; not where SNR is relatively constant, and not where gain and zero offset are unstable.

Means enabling (element 11) was a part of machine (element 13) called SN 2336. This indicator provided the power, drive for I_{sm}, and conditioning for the sensor, 5" clip #88, etc. It also provided switching , filtering, and combining for the "Combiner" species.

Substantially Increase

Substantially increase said SNR (element 12) is presented in the Abstract:

1995 page 53 Line 3-4	This invention has first been applied to Swain Meter® type clamp-on DC ammeters. Some results are good - the benefit in SNR is between 2 and 20, generally more like 10 times.

This applies to the "Combiner" species.

The benefit with the "Better SNR" species was two to one. This is shown in figure 5. Operation was at point (B).

Means Enabling and Machine

The method used to build means enabling (element 11) and machine (element 13) is described for the "Combiner" species on page 1, and also in the Abstract, page 52.

1995 page 1 Line 7-11	The method used is usually to find or construct a sensor which has a signal to noise ratio SNR which changes a lot when its operating parameter is selectively modulated. The output of the lower noise sensor is combined with the output of the higher noise sensor so that, in the ideal case, the noise cancels, but a good signal remains. The easier way may be to take part of the output of the higher noise sensor and subtract it from the output of the lower noise sensor.
1995 page 52 lines 8-15	Often, the method involves operating the sensor in first one state and then another wherein the operating parameter has conditions where the sensor is stable, reproducible, and reliable, and wherein the SNRs are substantially different. The output of a state is combined with the output of another state in such a way that the noise cancels but a signal remains. Often the output in a state having greater noise is attenuated until it matches the noise content of another state having less

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noise. Then these outputs are subtracted. The difference is the more accurate error corrected output. In the ideal case, the difference has no noise output because the noise in the output from one state canceled the noise in the output of the other state.

However there is good signal in the difference, typically half as large as before subtraction, because the SNR in one state is preferably about double that in another state.

The structure of means enabling (11) and machine (13) used for testing this invention are given in figure 9, page 62, for the "combiner species".

Figure 9, 1995, page 62

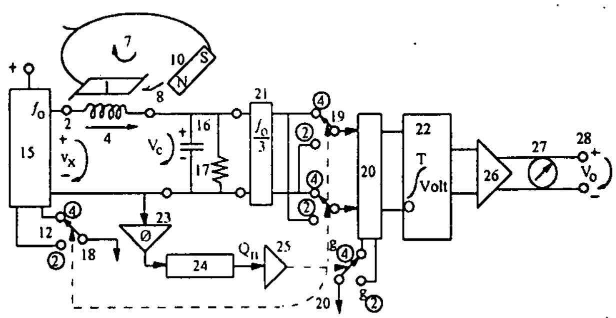

Fig. 9: A switching implementation of the mathematical relationship shown in Eq. i).

The method and structure I used and the results I got with this "combiner" species embodiment are given on page 32 to 36. When adjusted, the SNR benefit was generally better than 10 to one.

Symbol

A simplified representation for claim 45 is figure 13.

1995 page 66, figure 13

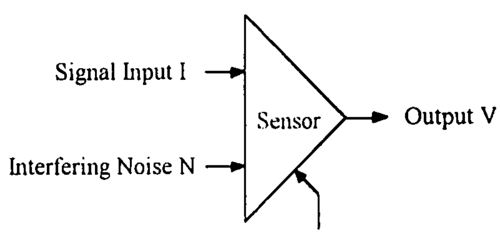

Fig. 13. General representation of a Sensor described in Eq. a) thru Eq. j).

Orthogonal

Operating parameter Q (element 10) is orthogonal, i.e., it modulates (multiplies) sensitivities $g = \frac{\delta V}{\delta I}$ and $\Psi = \frac{\delta V}{\delta N}$. It does not add to or subtract from I or N.

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Figures 9 and 13 are implementation and simplified symbol for the general relation for the combiner form of claim 45:

Basic Equation

$$V_C = V_B - V_A/\eta$$

$$V_C = g_B I + Z_B - (\frac{1}{\eta})(g_A I + Z_A)$$

$$V_C = (g_B - \frac{g_A}{\eta})I + (Z_B - \frac{Z_A}{\eta})$$

By Eq. h) $Z_B = g_B \Psi_B N$; and $Z_A = g_A \Psi_A N$. Then

eq i), etc.

$$\boxed{\text{Eq. i)}\quad V_C = (g_B - \frac{g_A}{\eta})I + (g_B \Psi'_B - \frac{g_A \Psi_A}{\eta})N.}$$

This is a more basic equation, i.e., a general method.

1995 page 22 The second term is the error due to noise which we want to cancel. Then the coefficient of noise N will be zero if:

$$g_B \Psi_B = \frac{g_A \Psi_A}{\eta}, \text{ or}$$

$$\frac{1}{\eta} = \frac{g_B}{g_A}\frac{\Psi'_B}{\Psi_A}$$, and remembering that $\frac{\Psi_B}{\Psi_A} \equiv ß$, we have

$$\text{Eq. j)}\quad \frac{1}{\eta} = \frac{g_B}{g_A} ß, \quad \text{or} \quad \eta = \frac{g_A}{ß g_B}.$$

So the requirement for noise N cancellation is that the sensor be designed so that the divisor factor η is set according to Eq. j), using measured or calibrated characteristics of the sensor as shown in Fig. 6.

Note that if $g_A = g_B$; $\eta = \frac{1}{ß}$; or $\eta ß = 1$ is close to the error cancelation requirement.

Antecedents for claim 45 plus figures 9 and 13 are given in figures, drawings, and the related text. For example:

Structure of a clamp-on Direct Current Sensor

Figure 1 outlines the structure of a clamp-on sensor used in this invention.

1995 page 55, figure 1

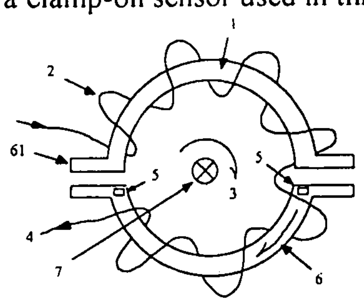

Fig. 1: A clamp-on sensor

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The operation is given on page 9, 10, etc.

Figure 1 above is the sensor (element 1) in figure 9 above. In both of these figures:

1 is the core.
2 is the winding N_S.
3 is the magnetomotive force H.
4 is the current in winding N_S.
5 only applies if a Hall device is used.
6 is the flux flowing in the core 1.
7 is element 3, the input current I.

Undesired Interference N

Antecedent for claim 45 line 3, undesired interference N (element 4) is the magnet 10 in figure 9.

Undesired interference N (element 4) is the field 8 from the "magnet" 10 in figure 3. Description is given on page 10, etc.

1995 page 56, figure 3

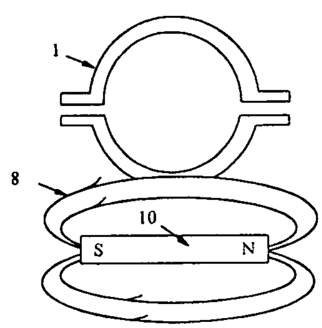

Fig. 3: A non-uniform magnetic field (H_n) 8 from a magnet acting on the core.

The core 1 is acted upon by the non-uniform field 8 of nearby "magnet" 10. This is element 4, the undesired interference N of claim 45. It can be the magnetism induced in the wall of a pipe carrying current I (element 3) to be measured. Or it can be a section of sheet metal in a car near the battery cable carrying the current I (3) to be measured. This magnetic noise (element 4) causes zero offset error in output V (element 2), so it is a form of undesired noise (element 4).

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5.3.66 Reading of Generic Claim 66 on the Specification and Drawings.

Method claim 66 is clearer and easier to read than others, in part because it is less dependent upon being read in the light of the disclosure.

The Invention: A brief summary of what my invention is all about is given on pages 8 and 9, below:

Introduction

1995 Page 8 Line 1-5

Swain Meter type clamp-on DC ammeters have gained wide acceptance because they are generally sensitive and accurate and available in a variety of forms for measuring 10 ma. to 500 Amp. direct current with sensors from ¼" to 5 feet in diameter. A clamp-on type sensor is shown in Fig. 1 herein.

1995 Page 8 Line 11-17

The output voltage V is sensitive to an input signal current I, and also to an interfering noise N which causes an output zero offset Z. Fig. 13 represents a sensor with functional symbols. An equation can be written to relate these:

Accuracy is dependent on g - this may be 1.000 V per Amp on a particular range* - and on Z. The values of g and Z should be constant over all values of input signal I, and also over all values of noise interference N.

1995 Page 9 Line 5-11

The most difficult type of interference noise N to control has been that due to a strong non-uniform magnetic field H_n such as that shown in Fig. 3. A stray magnet, perhaps in a weld in a pipe, a sector of magnetized sheet metal in an automobile near the battery cable, or a magnetized fastener near the sensor can produce a considerable zero offset error Z. When the clamp-on sensor is moved from nearby to really around the conductor carrying the current to be measured, the intensity and direction of the effective non-uniform field H_n changes, and this changes the zero offset Z, and so reduces the accuracy of output V.

Claim 66

This generic method claim has not been examined on merit. It was filed 3 years ago.

The elements of claim 66 are underlined, and numbered on the right.

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Claim 66

Line # Element #

I claim a method for making a more accurate sensor with implement for at least one of measurement or control, made in steps: 1, 2

obtain a said sensor having an output V responsive to a physical quantity input I, the gain g given by 3, 4, 5

$$g \equiv \frac{\delta V}{\delta I}, \text{ and}$$

said output V is also responsive to an undesired error producing interference N, the sensitivity Ψ being 6, 7

$$\Psi \equiv \frac{\delta V}{\delta N}, \text{ and}$$

in addition, said sensor has an operating parameter of magnitude Q which modulates said Ψ, and to a lesser extent said gain g; 8, 9

at least one of calibrate, or make by a proven process, or otherwise assure that said sensor has a strong Essential Characteristic evidenced by observing that said Sensitivity Ψ changes a lot more than said gain g when said magnitude Q is driven over a practical range of values; 10, 11

and at least one of:

provide an error reducing form of said implement, fitted to support said sensor, and 12, 13, 14

also fitted to drive said magnitude Q and hold it at a constant value, and by at least one of measurement or a proven process, set said magnitude Q at a value corresponding to a said sensitivity Ψ which is a lot less than heretofore while said gain g is still good, thus making said sensor with implement substantially more accurate than comparable transducers for said input I in the presence of said interference N; 15, 16, 17, 18, 19, 20

or,

provide an error correction form of said implement having an output V_c, and also fitted to support said sensor, and 21, 22

further equipped with state means 23

driving said magnitude Q,

dividing the said output V, and 24

combining the said output V, and 25

wherein said combining is coupled to said implement output V_c; 26

construct the said state means so that there is at least one state "A" wherein 27

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Claim 66, Contd.

said means drive said magnitude Q to produce a large said sensitivity Ψ with good said gain g, 28
and also said sensor output V is largely said divided and made available for said combining; 29

further construct said state means so that there is also at least one state "ß" wherein 30

said means drive said magnitude Q to produce a small said sensitivity Ψ with good said gain g, 31
and
also said sensor output V is but slightly said divided and made available for said combining; 32

to get said error correction, at least one of:

set by a proven process, or adjust at least one of a said means dividing or said means combining 33, 34
so that

the said largely divided said large Ψ of said state "A" is about equal to and opposite from the said 35
but slightly divided said small Ψ of said state "ß", and
thereby the said Ψ's approximately cancel in said combiner so that 36
the said error producing interference N is mostly removed from said output V_c; and 37

not withstanding there is remaining at said V_c a large part of said responsiveness to said physical 38
quantity input I;

so that thereby said sensor with implement is a whole lot more accurate than comparable 39
transducers for said physical quantity input I in the presence of said interference N.

Introductory Reading

A convenient antecedent for the first elements of claim 66 is the introduction on pages 8 and 9.

The introduction of my 1995 Application shows that the sensor (element 1) with implement (element 2) is a clamp-on direct current ammeter having a voltage output V (element 3) which is linearly proportional to physical quantity input I (element 4) by the sensitivity or gain factor g (element 5). This is shown on line 5 of claim 66.

By use of this invention, the zero offset error Z is to be minimized in so far as it is due to a non-uniform magnetic field H_n. I discovered that this appears in parts of the wall of a gas pipe having cathodic protection, or in the steel of an automobile near a battery cable.

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5.3.66

On page 9 I call this interference noise N. In claim 66 it is undesired error producing interference N (element 6). The sensitivity Ψ (element 7) determines the change in output V per unit noise input N as shown on line 8 of claim 66.

Essential Characteristic

The DISCOVERY provides antecedent for the element Essential Characteristic.

If the interference sensitivity Ψ can be reduced a lot more than the input sensitivity g using selective modulation of Ψ and g, then accuracy can be increased.

By the grace of our Lord and Savior Jesus Christ I discovered that this can be done on some of our sensor clips and clamps. I adjusted the magnitude Q of the operating parameter and discovered that selective modulation of Ψ and g was present. The DISCOVERY is on page 11.

DISCOVERY

1995 Page 11 The inventor discovered that the output V of many Swain Meter clamps was a lot less sensitive (1/2 to 1/3 in some sensors) to a change in the intensity of a non-uniform magnetic field H_n when the magnitude of an operating parameter I_{sm} was doubled or tripled. And the sensitivity (gain) to a change in signal input current I stayed constant to within a few percent.

The operating parameter (element 8) of claim 66 was used to modulate (element 9) the sensitivity (element 7) to a change in the non-uniform magnetic field H_n (interference N, element 6). The sensitivity g (element 5) to the input (element 4) stayed about the same.

This is the Essential Characteristic (element 10) that a sensor must have, and it must be good like figure 4 if this invention is to be useful. Noise sensitivity Ψ (element 7) changes a lot more (element 11) than gain g (element 5) when operating parameter magnitude Q (element 8) is driven over a practical range of values.

The method is to find or construct a sensor, and to then test it as shown in DISCOVERY and figure 4 to see that the sensor has the Essential Characteristic, and also to define the range of magnitudes of operating parameter Q within which the Essential Characteristic is good, and within which the sensor is stable and reproducible.

The Essential Characteristic (element 10) found in 5 inch diameter aperture clip #88 is stated on page 11 of my 1995 Application.

1995 Page 11 Essential Characteristic

Fig. 4 shows the approximate sensitivities for a five inch diameter aperture clip #88. This is an illustration of a sensor having the essential characteristic:

Firstly, the signal gain g (13) sensitivity to signal input I (7) is constant within a few

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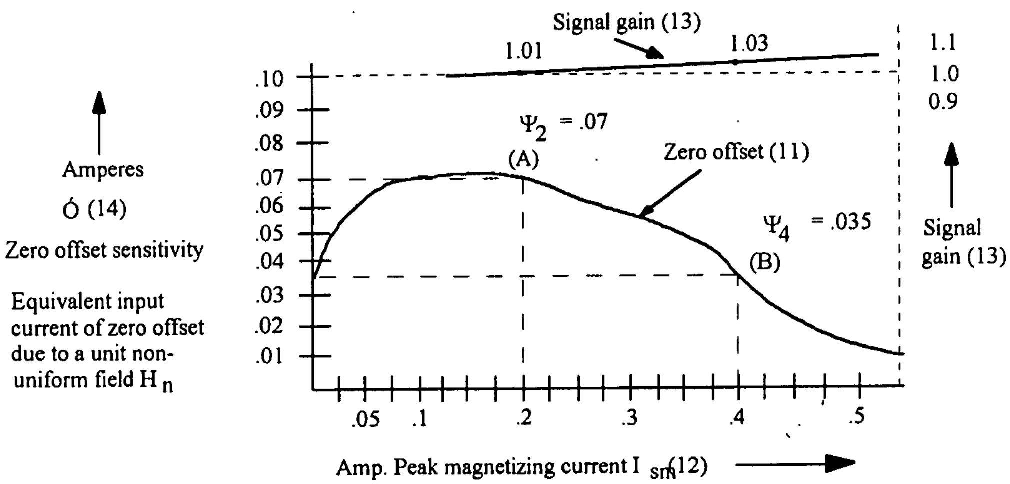
percent as an operating parameter I_{sm} (12) changes from 0.18 A to 0.5 Amp peak; and

Secondly, the zero offset (11) sensitivity to a unit change in intensity of a non-linear magnetic field H_n (8) is reduced to well under half over the same range of I_{sm} (12).

The sensor is to be calibrated, or built right, so that a good essential characteristic is present. The behavior of 5" clip #88 is graphed in figure 4.



1995 page 57
Figure 4

Fig. 4

Normalized Signal Gain (g) vs. I_{sm}
and
Normalized Zero Offset from H_n vs. I_{sm}
for
Five inch diameter aperture sensor #88.

In figure 4 it is apparent that Ψ (element 7) changed (was modulated) a lot more (element 11) than signal gain (element 5). The modulation (multiplier) on Ψ was ½ as the magnitude of the operating parameter (element 8) changed from 0.2 to 0.4 Amp. However, the multiplier on the signal gain g was only 1.02.

Note that signal gain and Ψ are modulated by the magnitude of the operating parameter I_{sm}, but I_{sm} does not directly add to or subtract from the output. This is what I call orthogonal.

The signal is good, but the interference N is ½, so the signal to noise ratio SNR is twice as good at (B) as at (A).

Error Reduction

The error reducing form (element 12) of the invention is seen at point (B) in figure 4. I was slow to realize its value because I had set out to cancel error, but eventually realized that a 2 or 3

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to one improvement (1/2 to 1/3 zero offset error, i.e., noise) was worthwhile. I call this the "Better SNR" species. We sell it as the MER Meter (Magnetic Error Reduction).

The method for error reduction is to get data and plot the equivalent of figure 4. Then adjust the magnitude of the operating parameter for operation at the equivalent of point (B).

The implement (element 2) is also fitted (element 13) to support (element 14), i.e., power, buffer, etc., the sensor, and to drive (element 15) the operating parameter to several magnitudes Q (element 8). Then the sensitivity Ψ (element 7) to interference N (element 6) is to be measured, until a magnitude of Q (element 8) is found where the needed reduction in sensitivity to interference N is sufficient, the gain g (element 5) is still good, and the whole is stable and reliable. Once found, this magnitude Q (element 8) is set (element 17) and held (element 16).

In the example using 5" clip #88 the method was: during measurement point (A) in figure 4 was located, and search continued until finding the operating parameter magnitude Q corresponding to a favorable Ψ (Ψ = .035) and favorable signal gain (g = 1.03). Then the operating parameter (I_{sm} in figure 4) was set and held at 0.4 Amp peak magnetizing current. Operation is then at point (B) in figure 4.

Thus Ψ is a lot less than before (element 18) and gain g is still good (element 19) so the sensor and implement are substantially more accurate (element 20). The signal to noise ratio (SNR) is twice as good at point (B) than at point (A).

When I first did this, I was interested to see that we had operated near point (A) for years. Operating at point (B) was a major improvement. But it required such low sensor winding resistance and stressed the inverter so much that we eventually changed from 6 Volt to 12 Volt battery power. The method included fitting (element 13) the implement (element 2) so that it supported (element 14) the sensor at point (B) as well as point (A).

<u>Error Correction</u>

The error correction (element 21 in claim 66) form can be used to approximate error cancellation by nulling out most of the interference N. I call this the "Combiner" species. It is generally more complex than error reduction. The approach is given on page 1 of my application.

1995 Page 1 Line 8-14

> The method used is usually to find or construct a sensor which has a signal to noise ratio SNR which changes a lot when its operating parameter is selectively modulated. The output of the lower noise sensor is combined with the output of the higher noise sensor so that, in the ideal case, the noise cancels, but a good signal remains. The easier way may be to take part of the output of the higher noise sensor and subtract it from the output of the lower noise sensor. Two sensors can be used, or the operating parameter of one sensor can be modulated (driven) from a higher to lower noise state.

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More detail is given in the Abstract.

1995 page 52 Line 8-17

Often, the method involves operating the sensor in first one state and then another wherein the operating parameter has conditions where the sensor is stable, reproducible, and reliable, and wherein the SNRs are substantially different. The output of a state is combined with the output of another state in such a way that the noise cancels but a signal remains. Often the output in a state having greater noise is attenuated until it matches the noise content of another state having less noise. Then these outputs are subtracted. The difference is the more accurate error corrected output. In the ideal case, the difference has no noise output because the noise in the output from one state canceled the noise in the output of the other state.

However there is good signal in the difference, typically half as large as before subtraction, because the SNR in one state is preferably about double that in another state.

The error correction form (element 21) has an output V_c (element 22) which is the "more accurate error corrected output" of Abstract line 13 and 14 above. The state means (element 23) are noted on lines 10 and 11 above. Dividing (element 24) is called attenuated on line 12 above. Combining (element 25) is called "then these outputs are subtracted." Coupled (element 26) is called "the difference is the more accurate error corrected output".

Antecedent for state "A" (element 27) is point (A) on figure 4 above. "A large said sensitivity Ψ with good gain g" (element 28) is the coordinates of point (A) on figure 4; namely $\Psi_2 = .07$; and signal gain $g_2 = 1.01$. Antecedent for largely said divided (element 29) is "often the output in a state having greater noise is attenuated until it matches the noise output of another state having less noise." This is on lines Abstract 11-13 above.

State "B" (element 30 in claim 66) corresponds to point (B) on figure 4. Its coordinates are $\Psi_4 = .035$ and signal gain = 1.03. This corresponds to "a small said sensitivity Ψ with good gain g" (element 31). If the .07 Ψ_2 is divided by 2 it will equal 0.035 also. Then if the combining (element 25) is "subtracted" on line 13 above, the "difference has no noise output" on Abstract line 14 is the result.

In state B, the output V (element 3) is but slightly said divided (element 32) has antecedent in "until it matches the noise content of another state having less noise" on Abstract line 12-13 above.

The method calls for set by a proven process, or adjust (elements 33 and 34) to get the best cancel (element 36) of the interference N by balancing out the two interference N sensitivities Ψ_2 and Ψ_4 (element 7). Balancing out is when we get "about equal to and opposite from" (element 35). Antecedent is "the difference has no noise output because the noise in the output from one state canceled the noise in the output of the other state" on Abstract line 14-15 above. Antecedent

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for "Interference N is mostly removed from said output V_C" (element 37) is also on Abstract lines 13-15 above.

The output V_C has good sensitivity to physical quantity input I (element 4) because when half of state "A" was subtracted from all of state "B", the gains being about equal, the remainder is about half. This is rephrased on lines 16-17 of the above abstract. It is Antecedent for "there is remaining at said V_C a large part of said responsiveness to said physical quantity input I (element 38).

A whole lot more accurate (element 39) follows naturally since the noise is practically eliminated.

Implement (element 2) with sensor (element 1) used for testing this invention are given in figure 9, page 62, for the "combiner species".

Figure 9, 1995, page 62

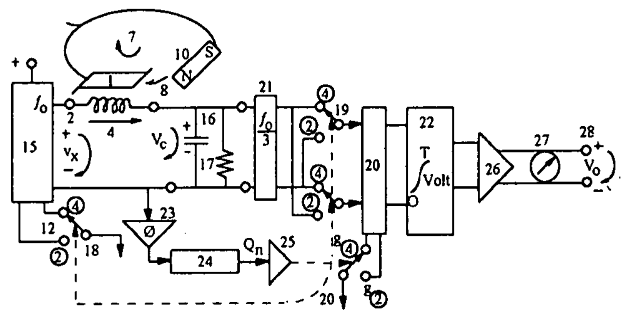

Fig. 9: A switching implementation of the mathematical relationship shown in Eq. i).

The method I used and the results I got with this "combiner" species embodiment are given on page 32 to 36. The SNR benefit when reasonably well adjusted was about ten to one.

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6

6 Issues Summarized

6.1 The first three issues are related. Argument is given in section 8.1, beginning on page 47.

6.1.1 Whether 3 year old generic method and apparatus claims 63-66, never having been examined on merit, may properly be finally rejected before examination on merit.

6.1.2 Whether claims 32-66, excepting only claim 45, can properly be finally rejected on the basis of discussion of only claim 45 when none have been examined on merit since my 148 page traverse of 6 grounds for rejection on 24 March 2000.

6.1.3 Whether the Examiner erred when he asserted, contrary to the record:

Examiner 1-29-03	By Applicant's admission in Paper No. 28 the fate of claim 45 determines the fate of all
Page 3, Line 3-4	claims so only claim 45 is discussed.

I did not so admit.

6.2 Whether generic apparatus claim 45, fully viewed in the light of the disclosure, has elements not found in any one of cited references Lee, Moser et al, Hubbard, Sweeny, or Swain, Re: 35 U.S.C. 102(b).

Argument is given in section 8.45.

6.3 Whether generic method claim 66, fully viewed in the light of the disclosure, has elements not found in any one of cited references Lee, Moser et al, Hubbard, Sweeny, or Swain, Re: 35 U.S.C. 102(b).

Argument is given in section 8.66.

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7 Grouping of Claims

Generic method claim 66 will, I think, handily overcome all ground of rejection, yet claim 66 has been rejected after 3 years without examination on merit. And likewise all other claims 32-66. I appeal this.

In 3 years only generic apparatus claim 45 has been examined on merit. This claim is finally rejected as anticipated by any one of 5 references, seemingly on inherent structure. I appeal this.

All claims 32-66 include the Basic Concept in broad or narrow form, in apparatus or method claims, and in generic or one of two species. This diversity is to avoid having all claims stand or fall together.

7.1 A Single Claim

Generic Method Claim 66 is my nomination if only one claim will be selected by the board.

7.2 Basic Concept

The basic concept in one form or another is a part of all of claims 32-66. The Basic Concept includes the DISCOVERY and the Essential Characteristic. The basic concept also includes the implement and/or means enabling the use of the Essential Characteristic so that the resulting output has a better SNR, and thus is a lot more accurate. This is shown in page 11 and in figures 5 and 9 among others.

DISCOVERY

1995 Page 11 The inventor discovered that the output V of many Swain Meter clamps was a lot less sensitive (1/2 to 1/3 in some sensors) to a change in the intensity of a non-uniform magnetic field H_n when the magnitude of an operating parameter I_{sm} was doubled or tripled. And the sensitivity (gain) to a change in signal input current I stayed constant to within a few percent.

1995 Page 11 Essential Characteristic

Fig. 4 shows the approximate sensitivities for a five inch diameter aperture clip #88. This is an illustration of a sensor having the essential characteristic:

Firstly, the signal gain g (13) sensitivity to signal input I (7) is constant within a few percent as an operating parameter I_{sm} (12) changes from 0.18 A to 0.5 Amp peak; and

Secondly, the zero offset (11) sensitivity to a unit change in intensity of a non-linear magnetic field H_n (8) is reduced to well under half over the same range of I_{sm} (12).

The sensitivities to signal g and noise Ψ are converted to signal to noise ratio SNR and plotted in figure 5 as a function of Operating Parameter I_{sm}.

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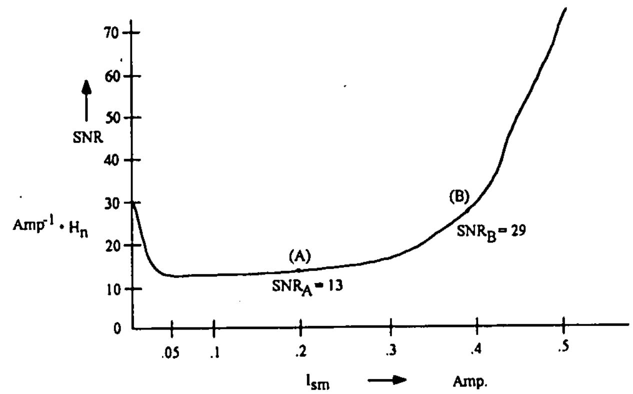


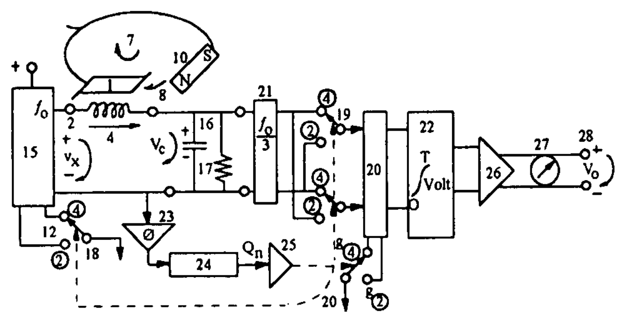
Figure 5
Signal to Noise Ratio (SNR) for Non-Uniform Field H_n
vs.
Operating Parameter I_{sm}
for
5" dia. aperture clip #88 in SN 2336

Figure 5
1995 Page 58

output
input

$$SNR = \frac{\delta V / \delta I}{\delta V / \delta N} \Big\} \frac{\text{output}}{\text{noise}}$$

$$= \frac{\text{gain}}{\text{gain} \cdot \frac{\delta O}{\delta N}} \leftarrow \frac{Z}{g} = \text{equivalent input offset I per unit non-uniform field } H_n$$



1995 Page 62, figure 9

Fig. 9: A switching implementation of the mathematical relationship shown in Eq. i).

7.3 Species "Better SNR" and Species "Combiner"

There are seven claims in the simpler species "Better SNR". There are 23 claims of the more complex species "Combiner".

7.4 Generic Claims

There are five generic claims; claim 45 plus claims 63-66.

4-14-03

7.5 Claim Nominations

1) If one claim must be selected in each group:

2) Generic claim 66 is my nomination for the generic group. Claim 45 is shorter, but more reliant on the disclosure.

3) "Combiner" claim 32 is my nomination for this species.

4) "Better SNR" claim 60 is my nomination for this species. This is the most limited claim.

5) If only one claim can be selected among the 35 claims in this case I nominate method claim 66, then apparatus claim 65.

7.6 Generic Claims 45 and 63-66 include both the species "Better SNR" and species "Combiner".

Claim 45 is attractive for its brevity. However, it may be faulted as excessively broad or vague, hence generic method and apparatus claims 63-66 having progressively more detailed process and structure.

If I had to stake all on one claim I would nominate method claim 66. The 39 elements are less dependent on being read in the light of the disclosure than in claim 45.

7.7 The species "Combiner" claims are 32-42 and 47-58; 23 in all. The terminology, detail and breadth are changed so that at least a few will likely survive if the others are rejected.

Method claim 32 is attractive for its brevity.

7.8 The species "Better SNR" claims are 43, 44, 46, and 59-62; 7 in all.

Apparatus claim 60 is limited in scope to cover little more than the MER Meter as produced today.

4-14-03

8c

8 Argument

There are three argument sections:

8.1 Support for Comparing Generic Claims 63-66 with the Cited References, especially Method Claim 66.

At least method claim 66 should be examined on merit because:

- since filing on 24 March 2000 it has never been examined on merit.

- it is more apparent that its elements are not found in the cited references.

8.45 Traverse of the Examiner's rejection of Claim 45

This refutes, in detail, each and every basis for rejection put forth by the Examiner on 29 Jan 03.

8.66 Traverse of the Examiner's final rejection of Claims 32-66 based on the fact that elements in Claim 66 are not in the cited references.

Three years after proper filing, claims 63-66 still have not been examined on merit. The elements of claim 66 are presented and shown to be absent in the cited references.

8.1 Support for Comparing Generic Claims 63-66 with the Cited References, especially Method Claim 66.

8.1.1 Summary

Properly filed over 3 years ago, generic claims 63-66 have never been examined on merit, yet are now finally rejected. This is improper in view of MPEP 2106-II.

MPEP 2106-II
Page 2100-5

II. Determine What Applicant Has Invented and Is Seeking to Patent

It is essential that patent applicants obtain a prompt yet complete examination of their applications. Under the principles of compact prosecution, each claim should be reviewed for compliance with every statutory requirement for patentability in the initial review of the application, even if one or more claims are found to be deficient with respect to some statutory requirement.

The Examiner erred in discussing only claim 45. All other claims 32-66 have received no examination on merit since my 148 page traverse of 24 March 2000 covering 6 different grounds for rejection.

4-16-03

8.1.1

These claims were improperly bypassed, apparently because in traversing the Examiner's third requirement to restrict, I repeated that I rely upon the basic concept (the Essential Characteristic plus enabling implement means to use it), and that it is in every claim in one form or another. I mentioned claim 14 by way of example.

The Examiner was mistaken in writing that I admitted that the fate of claim 45 determines the fate of all claims, and that if claim 45 is not patentable, no claim of the present application is patentable.

I did not so admit.

Section 8.1:

- shows how it happened that only claim 45 was discussed, bypassing the other claims 32-66.
- shows that it would make no sense for me to rely solely on claim 45, and that I did not so do.
- defines the basic concept,
- presents claims 45 and 66 with elements underlined and numbered.
- shows that these elements are not present in the cited references. Therefore rejection is improper.
- shows precise, quantitative antecedent support in my 1995 application.

8.1.2 Claims 63-66 should be examined on Merit

Generic claims 63-66 were properly filed on 24 March 2000. After 3 years they have not been examined on merit. This is contrary to MPEP 2106:

MPEP 2106-II
Page 2100-5

II. Determine What Applicant Has Invented and Is Seeking to Patent

It is essential that patent applicants obtain a prompt yet complete examination of their applications. Under the principles of compact prosecution, each claim should be reviewed for compliance with every statutory requirement for patentability in the initial review of the application, even if one or more claims are found to be deficient with respect to some statutory requirement. Thus, Office personnel should state all reasons and bases for rejecting claims in the first Office action. Deficiencies should be explained clearly, particularly when they serve as a basis for a rejection. Whenever practicable, Office personnel should indicate how rejections may be overcome and how problems may be resolved. A failure to follow this approach can lead to unnecessary delays in the prosecution of the application.

4-16-03

"Reasons and bases for rejecting claims" 63-66 have yet to be stated.

These generic claims are crafted with a view to overcoming potential weakness seen while preparing my 148 page traverse of 6 separate bases for rejection, mailed 24 March 2000. Two are apparatus, two method, two rather brief, and two longer so as to be less dependent on being read in the full light of my disclosure of 27 December 1995.

I now especially value method claim 66 because it is more apparent that its 39 elements are not found in the cited references. So by MPEP 2131:

MPEP 2131

> TO ANTICIPATE A CLAIM, THE REFERENCE MUST TEACH EVERY ELEMENT OF THE CLAIM
>
> "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). "The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

Claim 66 is not anticipated and is fit to be granted.

Claims 32-65 are likewise not anticipated when read in the full light of the disclosure, but it may not be as readily apparent.

8.1.3 Circumstances relating to the Examiner's discussion of only claim 45.

Examiner's statement

Claims 63 to 66 were bypassed when the Examiner acted on two misconceptions on 25 September 2002 and again on 29 January 2003.

Examiner 1-29-03 Page 2, Line 13-14	By Applicant's admission if claim 45 is not patentable no claim of the present application is patentable.
Examiner 1-29-03 Page 3, Line 3-4	By Applicant's admission in Paper No 28 the fate of claim 45 determines the fate of all claims so only claim 45 is discussed.

I did not so admit.

4-16-03

8.1.3

<u>Sense</u>

It would make no sense for me to rely only on then canceled claim 14. I worked to craft and paid for filing 35 claims of diverse nature. Some are short, some in detail, some apparatus, some method, some generic, some combiner species, and others Better SNR species. This in hope that at least a few would survive if weakness were found in others.

<u>Restriction</u>

This may have come about because the Examiner misconstrued a statement in my response of 19 November 01 (filed 18 December 01) to the third requirement to restrict:

Swain 18 Dec 2001 bottom page 3	"My traverse relies on the fact that the basic concept (claim 14) is in every claim, so no claim would be patentable over another because it would lack novelty outside of this application."

Note that I relied on the "basic concept", not claim 14, mentioned in passing as an example of a claim including the basic concept.

I filed claims 63-66 on 24 March 2000 to expand my diverse claim base to increase the probability of a few survivors should some claims be lost. In December of 2001 I certainly would not deliberately void 34 claims in favor of then canceled claim 14.

<u>I rely on the Basic Concept</u>

Contrary to the examiner's assertion, I never stated that I relied on any one single claim. Much less a canceled claim. It is the "basic concept" that I rely upon. Claim 14 was mentioned as an example. If I had wanted to rely on a single claim, I could have canceled claims 32-66, save for claim 45. I did not because the "basic concept" is in my claimed invention, all claims 32-66.

MPEP 2141.02 states:

> THE CLAIMED INVENTION AS A WHOLE MUST BE CONSIDERED
>
> In determining the differences between the prior art and the claims, the question under 35 U.S.C. 103 is not whether the differences <u>themselves</u> would have been obvious, but <u>whether the claimed invention as a whole would have been obvious</u>. *Stratoflex, Inc.* v. *Aeroquip Corp.*, 713 F.2d 1530, 218 USPQ 871 (Fed. Cir. 1983); *Schenck* v. *Nortron Corp.*, 713 F.2d 782, 218 USPQ 698 (Fed. Cir. 1983)

I ask that my claimed invention be considered as a whole, especially generic claims 45, 63, 64, 65, and 66.

4-16-03 ✓

I rely on the "basic concept". That I did indeed rely on the basic concept - not some single claim - is shown by what I wrote on the first three pages of my traverse of the third requirement to restrict. All this was written before any mention of canceled claim 14. Claim 14 was canceled on 24 March 2000.

Before any mention of claim 14 I presented one aspect of the basic concept - figure 5 - on page one of my response dated 20 November 2001 and filed 18 December 2001. This is an example of the Essential Characteristic, a unifying element, which is present in every claim in one form or another.

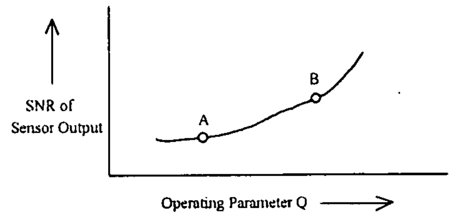


Figure 5 is an illustration of a sensor having the "Essential Characteristic".

I continued on Page 2; still before any mention of claim 14, I wrote of how the sensor is operated to make use of the Essential Characteristic to improve accuracy.

The simplest is "better SNR".

With it we double or triple the accuracy of our clamp-on direct current ammeters when measuring a small current in the presence of noise in the form of a nearby magnet. We did this by operating our clamp-on sensor at point B instead of point A as we had done in the past. By the grace of God, operation at point B works a lot better, and reliably so, in many and diverse applications.

My original objective was to cancel noise. Conceptually, this was achieved by combining the outputs of two sensors, one operated at point A, and the other at point B in Figure 5. The noise output at A is 2 times that at B, but the signals are about equal. So when A is divided down to half, the noises are equal. The combiner subtracts ½ of A from B. The result is noise cancellation, but half the signal is still available for use - noise free.

Examples of Claims

Still before any mention of claim 14 I showed excerpts from three generic claims. Each includes the Essential Characteristic plus means for using it to improve accuracy by reducing error in the output of the sensor.

Claim 45 is for a sensor having the **Essential Characteristic** together with means enabling it to substantially increase SNR in a machine, or independently.

Claim 63 is for a machine including a sensor having the **Essential Characteristic** plus support means to considerably reduce (noise) interference ("better SNR species"), or to practically cancel (noise) interference ("combiner" species).

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8.1.3

Claim 66 is for a method for making a more accurate sensor with implement, including the **Essential Characteristic**, all fitted for reducing the sensitivity to (noise) interference
("better SNR species"), or to
approximately cancel the (noise) interference (combiner species).

Finally, in traversing the third requirement to restrict, I quoted the examiner's statement of September 22, 1998, thusly:

> 1. Because Applicant has indicated that no patentably distinct inventions or species are present the Restriction Requirements of February 21, 1997 and January 16, 1998 are withdrawn. It is noted that Applicant states on page 1 (actually the second page) of the Amendment of May 29, 1997: "My traverse relies on the fact that the basic concept (claim 14) is in every claim, so no claim would be patentable over another because it would lack novelty outside of this application."

Note that it is the "basic concept" - not canceled claim 14 - that I rely upon. Mention of canceled claim 14 is an aside. It is an example of a generic claim. Present claim 45 is another example. So also are claims 63, 64, 65, and 66.

I rely on the "Basic Concept" which appears in the claims, especially the generic claims.

All Claims considered

On page 2100-8, MPEP 2106 states that "...their claims must be considered...", not just one claim.

> Finally, when evaluating the scope of a claim, every limitation in the claim must be considered. Office personnel may not dissect a claimed invention into discrete elements and then evaluate the elements in isolation. Instead, the claim as a whole must be considered. See, e.g., *Diamond* v. *Diehr*, 450 U.S. at 188–89, 209 USPQ at 9 ("In determining the eligibility of respondents' claimed process for patent protection under 101, their claims must be considered as a whole. It is inappropriate to dissect the claims into old and new elements and then to ignore the presence of the old elements in the analysis.

I request that all claims 32-66 be considered, especially claim 66.

8.1.4 Definition of the Basic Concept

The "Basic Concept" has at least 2 elements:

a) The Essential Characteristic must be shown by the sensor.

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8.1.4

b) In operating the sensor, the Essential Characteristic must be utilized.

The Essential Characteristic in one wording or another is a primary limitation in every claim. And so is operation making use of it.

Antecedent for both the sensor and the implement to operate the sensor is in the disclosure. Examples are:

The Sensor

By the Grace of our Lord and Savior Jesus Christ I made the DISCOVERY:

DISCOVERY

1995 Page 11 Line 11-15 The inventor discovered that the output V of many Swain Meter clamps was a lot less sensitive (1/2 to 1/3 in some sensors) to a change in the intensity of a non-uniform magnetic field H_n when the magnitude of an operating parameter I_{sm} was doubled or tripled. And the sensitivity (gain) to a change in signal input current I stayed constant to within a few percent.

I found that for this invention to work a sensor had to have the Essential Characteristic:

Essential Characteristic

1995 Page 11 Line 16-22 Fig. 4 shows the approximate sensitivities for a five inch diameter aperture clip #88. This is an illustration of a sensor having the essential characteristic:

Firstly, the signal gain g (13) sensitivity to signal input I (7) is constant within a few percent as an operating parameter I_{sm} (12) changes from 0.18 A to 0.5 Amp peak; and

Secondly, the zero offset (11) sensitivity to a unit change in intensity of a non-linear magnetic field H_n (8) is reduced to well under half over the same range of I_{sm} (12).

I graphed the measurements made on 5" clip #88:

4-16-03

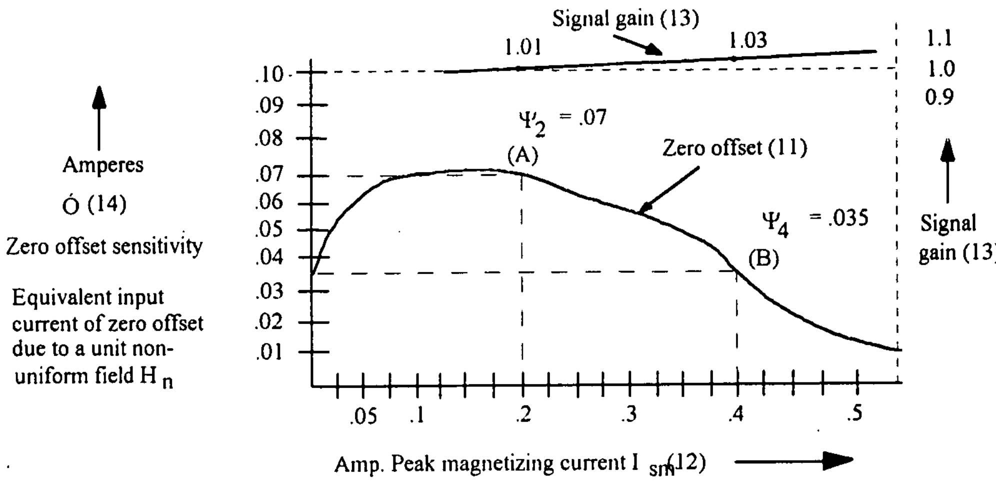

Fig. 4

Normalized Signal Gain (g) vs. I_{sm}
and
Normalized Zero Offset from H_n vs. I_{sm}
for
Five inch diameter aperture sensor #88.

The signal to noise ratio - SNR - is the reciprocal of the sensitivity Ψ to a non-uniform magnetic field H_n. SNR is shown in figure 5 which follows.

<u>The Implement</u>

For this invention to be useful, the sensor has to be operated so that noise is reduced and accuracy improved. This is done with means enabling, or an implement fitted to drive the operating parameter, condition the output, etc., and where needed to provide state means, division, combination, etc.

For the combiner species and example is figure 9.

Figure 9, 1995, page 62

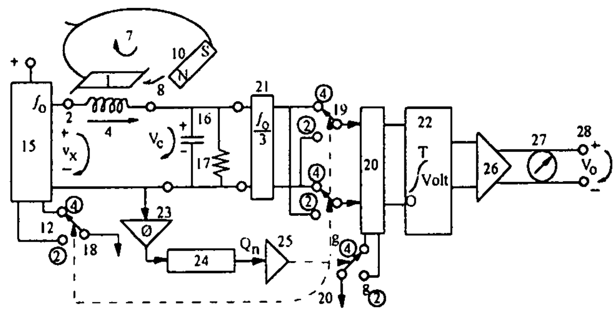

Fig. 9: A switching implementation of the mathematical relationship shown in Eq. i).

4-16-03

Antecedent for the Basic Concept

The "basic concept" is included in the first two paragraphs of the 1995 abstract.

(h) Abstract of the Disclosure. (annotated)

The accuracy of certain sensors is greatly improved by improving their signal to noise ratio (SNR) in the presence of an interfering noise. Sensors were discovered which have a SNR which substantially changes when an operating parameter is selectively modulated to different magnitudes. Some noise can be practically eliminated. In the simplest form, the sensor is operated where it is both stable and close to its best SNR. This is usually faster and less costly, but the noise is never completely eliminated.

Often, the method involves operating the sensor in first one state and then another wherein the operating parameter has conditions where the sensor is stable, reproducible, and reliable, and wherein the SNRs are substantially different. output of a state is combined with the output of another state in such a way that the noise cancels but a signal remains. Often the output in a state having greater noise is attenuated until it matches the noise content of another state having less noise. Then these outputs are subtracted. The difference is the more accurate error corrected output. In the ideal case, the difference has no noise output because the noise in the output from one state canceled the noise in the output of the other state.

There are at least two elements or steps, in the "basic concept" included in some form or another in the generic claims 45, 63, 64, 65, and 66; and for that matter, all claims 32-66:

a) A sensor having the Essential Characteristic that its SNR changes a lot when the magnitude of the Operating Parameter is modulated, and also

b) the sensor is operated to take advantage of the Essential Characteristic.

Claim 45

Claim 45 includes the basic concept.

A reading of claim 45 is given in section 5.3.45.

Line	Annotated Claim 45	Element #
1	An improved Sensor	1
	having an output V responsive to a physical quantity I, and also	2, 3

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Claim 45, Contd

Line | Element #

responsive to an undesired interference N, 4
the ratio of 5
the said responsiveness of the said output V to said physical quantity I
in relation to
the said responsiveness of said output V to said interference N
being defined as the Sensor's signal to noise ratio SNR, 6
which can be stated in symbolic form:

$$SNR \equiv \frac{\delta V / \delta I}{\delta V / \delta N}\text{, where}$$

δV is a change in said output V,
δI is a change in said physical quantity I, and
δN is a change in said interference N; and also
said Sensor is constructed to have the Essential Characteristic that the 7
said signal to noise ratio SNR is
substantially altered by Selective Modulation of an Operating Parameter Q, and 8, 9, 10
means enabling said Sensor to substantially increase said SNR in at least one of: 11, 12
a Machine, or independently. 13

Claim 66

Claim 66 includes the basic concept.

A reading of claim 66 appears in section 5.3.66.

Annotated Claim 66

Line # | Element #

I claim a method for making a more accurate sensor with implement for at least one of measurement or control, made in steps: 1, 2

obtain a said sensor having an output V responsive to a physical quantity input I, the gain g given by 3, 4, 5

$$g = \frac{\delta V}{\delta I}\text{, and}$$

said output V is also responsive to an undesired error producing interference N, the sensitivity Ψ being 6, 7

$$\Psi = \frac{\delta V}{\delta N}\text{, and}$$

in addition, said sensor has an operating parameter of magnitude Q which modulates said Ψ, and to a lesser extent said gain g; 8, 9

at least one of calibrate, or make by a proven process, or otherwise assure that said sensor has a strong Essential Characteristic evidenced by observing that said Sensitivity Ψ changes a lot more than said gain g when said magnitude Q is driven over a practical range of values; 10, 11

and at least one of:

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Element # 8.4

Claim 66 Contd. Line #

provide an error reducing form of said implement, fitted to support said sensor, and 12, 13, 14

also fitted to drive said magnitude Q and hold it at a constant value, and by at least one of 15, 16
measurement or a proven process, set said magnitude Q at a value corresponding to a said 17
sensitivity Ψ which is a lot less than heretofore while said gain g is still good, 18, 19
thus making said sensor with implement substantially more accurate than comparable transducers 20
for said input I in the presence of said interference N;

or;

provide an error correction form of said implement having an output V_c, and 21, 22
also fitted to support said sensor, and
further equipped with state means 23

driving said magnitude Q,

dividing the said output V, and 24

combining the said output V, and 25

wherein said combining is coupled to said implement output V_c; 26

construct the said state means so that there is at least one state "A" wherein 27

said means drive said magnitude Q to produce a large said sensitivity Ψ with good said gain g, 28
and also said sensor output V is largely said divided and made available for said combining; 29

further construct said state means so that there is also at least one state "B" wherein 30

said means drive said magnitude Q to produce a small said sensitivity Ψ with good said gain g, 31
and
also said sensor output V is but slightly said divided and made available for said combining; 32

to get said error correction, at least one of:

set by a proven process, or adjust at least one of a said means dividing or said means combining 33, 34
so that

the said largely divided said large Ψ of said state "A" is about equal to and opposite from the said 35
but slightly divided said small Ψ of said state "B", and
thereby the said Ψ's approximately cancel in said combiner so that 36
the said error producing interference N is mostly removed from said output V_c; and 37

not withstanding there is remaining at said V_c a large part of said responsiveness to said physical 38
quantity input I;

so that thereby said sensor with implement is a whole lot more accurate than comparable 39
transducers for said physical quantity input I in the presence of said interference N.

4-16-03

Claims 45 and 66 are not anticipated

The requirement of MPEP 2131 is not met by the cited references.

MPEP 2131

TO ANTICIPATE A CLAIM, THE REFERENCE MUST TEACH EVERY ELEMENT OF THE CLAIM

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). "The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

This will be shown when claims 32-66, especially claim 66, are examined as required by MPEP 2106, II.

MPEP 2106-II
Page 2100-5

II. Determine What Applicant Has Invented and Is Seeking to Patent

It is essential that patent applicants obtain a prompt yet complete examination of their applications. Under the principles of compact prosecution, each claim should be reviewed for compliance with every statutory requirement for patentability in the initial review of the application, even if one or more claims are found to be deficient with respect to some statutory requirement.

After 3 years claims 63-66 have not been examined.

I ask that at least claim 66 be examined. Hopefully, also claim 65.

4-16-03 ✓

8.45

8.45 Traverse of the Examiner's Rejection of Claim 45.

Introduction

Claim 45 is for a:

a) Means for overcoming the discovered problem - interference noise N - from a non-uniform magnetic field H_n.

b) Sensor constructed with the Essential Characteristic.

c) Means enabling constructed to operate said sensor with substantially increased signal to noise ratio (SNR).

The cited references do not set forth the structure and elements of claim 45 as required by MPEP 2131 for anticipation.

MPEP 2131
Page 2100-62

TO ANTICIPATE A CLAIM, THE REFERENCE MUST TEACH EVERY ELEMENT OF THE CLAIM

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). "The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989). The elements must be arranged as required by the claim, but this is not an *i·ssissimis verbis* test, i.e. identity of terminology is not re-·d. *In re Bond*, 15 USPQ2d 1566 (Fed. Cir. 199·

Claim 45 is for an "improved sensor" (element 1). I claim a sensor having quantitative, verifiable "substantially increase said SNR" (element 12). Every element of claim 45 has broad numerical and theoretical support in the disclosure.

The improved sensor is constructed to have the Essential Characteristic (element 7) that the signal to noise ratio SNR is substantially altered (element 8) by selective modulation (element 9) of an operating parameter Q (element 10). Quantitative examples include the DISCOVERY and Essential Characteristic sections of page 11, and also figures 4 and 5. Construction details are given on page 36.

To show that the sensor is improved, the claim defines signal to noise ratio SNR (element 6) and requires that it be substantially increased (element 12). Details are on page 36. The noise is the discovered undesired interference N (element 4), for example, a non-uniform magnetic field H_n near the sensor. Details are on page 9.

3-28-03

8.45

The Examiner's rejection cites references Lee, Moser et al, Hubbard, Sweeny, or Swain as fully anticipating claim 45. This is contrary to MPEP 2131 because the elements of claim 45, viewed in the light of the disclosure as required by 35 U.S.C., paragraph 6, are not in the cited references.

35 U.S.C. 112
Par. 6

An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

That this applies to the PTO is shown in MPEP 2106:

MPEP 2106
Page 2100-8

The plain and unambiguous meaning of paragraph six is that one construing means-plus-function language in a claim must look to the specification and interpret that language in light of the corresponding structure, material, or acts described therein, and equivalents thereof, to the extent that the specification provides such disclosure. Paragraph six does not state or even suggest that the PTO is exempt from this mandate, and there is no legislative history indicating that Congress intended that the PTO should be. Thus, this court must accept the plain and precise language of paragraph six.

The disclosure provides quantitative and analytic antecedent for claim 45. This is shown in the following pages.

In contrast, the cited references Lee, Moser et al, Hubbard, Sweeny, and Swain do not contain the structure or elements of claim 45.

The Examiner adds a magnet to Sweeny, changes the function of his control winding 47, omits the orthogonal structure of the operating parameter Q (element 10) and without quantitative support asserts that Sweeny has the Essential Characteristic. This is speculation. The Examiner offers no numerical basis to show that Sweeny necessarily does have it, as required by MPEP 2112.

MPEP
2112

EXAMINER MUST PROVIDE RATIONALE OR EVIDENCE TENDING TO SHOW INHERENCY

>The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993)(reversed rejection because inherency was based on what would result due to optimization of conditions, not what was necessarily present in the prior art); *In re Oelrich*, 666 F.2d 578, 581-82, 212 USPQ 323, 326 (CCPA 1981).<

~~105~~ 60
~~58~~

3-28-03

8.45

MPEP 2112 contd.

"In relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art." *Ex parte Levy,* 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990) (emphasis in original) (Applicant's invention was

The Examiner mistakenly asserts that Swain 1995 uses the same kind of core material as Swain 1970 and will thus inherently have the Essential Characteristic.

<u>1995 Sensor is built a lot differently from 1970 Sensor</u>

Swain 1995 used different steel, and up to 36 times more of it, handled differently on 5 inch instead of ¼ inch forms - i.e., up to 20 times larger. The winding had up to 10 times as many turns. The peak magnetization Ampere turns was up to 80 times greater. The cross section area was up to 36 times greater.

The 1995 means enabling at minimum requires an up to 8 times greater operating parameter magnitude (element 10). Some require switching and state means shown in figure 9 and pages 32 to 36.

The cumulative effect of this new construction is a difference in kind, not just degree. It is unlikely that Swain 1970 had a useful Essential Characteristic. And even if it did, Swain 1970 would still not anticipate claim 45 because Swain 1970 did not teach how to make use of the Essential Characteristic to substantially increase SNR (element 12). There was no teaching of the special means enabling (element 11) to reduce the noise output.

MPEP 2114 instructs that the prior art cannot anticipate the claim if there is a structural difference.

MPEP 2114
Page 2100-51

A PRIOR ART DEVICE CAN PERFORM ALL THE FUNCTIONS OF THE APPARATUS CLAIM AND STILL NOT ANTICIPATE THE CLAIM

Even if the prior art device performs all the functions recited in the claim, the prior art cannot anticipate the claim if there is any structural difference. It should be noted, however, that means plus function limitations are met by structures which are equivalent to the corresponding structures recited in the specification. *In re Ruskin,* 146 USPQ 211 (CCPA 1965) as implicitly modified by *In re Donaldson,* 29 USPQ2d 1845 (Fed. Cir. 1994).<

4-18-03

Cited references Lee, Moser et al, Hubbard, Sweeny, and Swain 1970 all lack what claim 45, viewed in the light of the disclosures, describes:

a) a defined undesired interference N.

b) a structurally specific sensor having the Essential Characteristic which is evaluated to see if it is strong enough.

c) a quantitative, structurally specific means enabling to operate the sensor, i.e., to use the Essential Characteristic to substantially increase the sensor's signal to noise ratio (SNR), thereby improving the sensor's accuracy.

Therefore the cited references do not anticipate claim 45.

Anticipation is not shown

Each of the five cited references is considered in what follows.

Present generic claims 45, 63, 64, 65, and 66, and moreover, all claims 32-66, are not anticipated by any or all of the cited references as is required for rejection under 35 U.S.C. 102(b).

MPEP 706.02(a) states:

> DISTINCTION BETWEEN 35 U.S.C. 102 AND 103
>
> The distinction between rejections based on 35 U.S.C. 102 and those based on 35 U.S.C. 103 should be kept in mind. Under the former, the claim is anticipated by the reference. No question of obviousness is present. In other words, for anticipation under 35 U.S.C. 102, the reference must teach every aspect of the claimed invention either explicitly or impliedly. Any feature not directly taught must be inherently present.

Lee, Moser, Hubbard, Sweeny, and Swain 1970 do not teach every aspect of claims 32 thru 66. Each is considered separately after a showing of my claim 45 and my 1995 implementation figure 9.

Swain 1995

Swain 1995 teaches an improved sensor. Claim 45 is short. It is shown below so that the board may see that the cited references do not fully anticipate, especially when viewed in the light of the disclosure. Apparatus claims 65 and method claim 66 have many more elements so are less dependent on the disclosure.

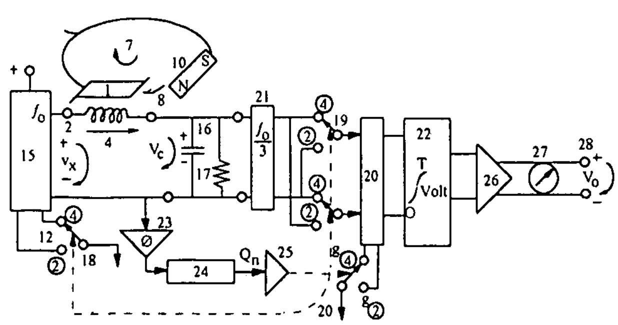
4-18-03

Annotated Claim 45

Line	Element #
Claim 45 (amended)	
An improved Sensor	1
having an output V responsive to a physical quantity I, and also	2,3
responsive to an undesired interference N,	4
the ratio of	5
the said responsiveness of the said output V to said physical quantity I	
in relation to	
the said responsiveness of said output V to said interference N	
being defined as the Sensor's signal to noise ratio SNR,	6
which can be stated in symbolic form:	
$SNR \equiv \frac{\delta V / \delta I}{\delta V / \delta N}$, where	
δV is a change in said output V,	
δI is a change in said physical quantity I, and	
δN is a change in said interference N; and also	
said Sensor is constructed to have the Essential Characteristic that the	7
said signal to noise ratio SNR is	
substantially altered by Selective Modulation of an Operating Parameter Q, and	8,9,10
means enabling said Sensor to substantially increase said SNR in at least one of:	11,12
a Machine, or independently.	13

Means Enabling

Figure 9 shows one "means enabling" (element 11 of claim 45) for an "error correction" (element 21 of claim 66) implement. Details are given on pages 32-36 of the 1995 specification.



1995, page 62
Figure 9

Fig. 9: A switching implementation of the mathematical relationship shown in Eq. i).

4-18-03

8.45

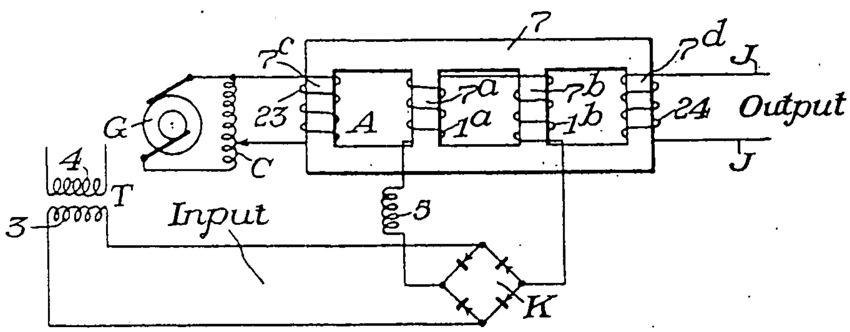
Lee

Mr. Frederick W. Lee filed Oct. 30, 1926 for his Electrical Translating Apparatus, Patent #1,797,268. The following excerpts show the nature of his teaching for controlling the power from the tracks to a locomotive.

March 24, 1931. F. W. LEE 1,797,268

ELECTRICAL TRANSLATING APPARATUS

Original Filed Oct. 30, 1926



Referring to the drawing, the reference character A designates a reactor having a ladder shaped magnetizable core 7 provided with two outer cross bars 7^c and 7^d, and two inner cross bars 7^a and 7^b. The outer cross bar 7^c is provided with a winding 23, and alternating current is supplied to this winding from a source which is here shown as an auto transformer C having its primary terminals connected with an alternator G.

spondingly large voltage. It follows that for small values of input energy the output current is small, but that with large values of input energy the variation in magnetic coupling between windings 23 and 24 produces a larger output current. The actual variation in the output current may be many times the variation in the input energy, the actual value of the output energy being dependent upon the design and proportions of the various parts.

Apparatus embodying my invention is particularly suitable for use in automatic train control systems of the continuous inductive type. In systems of this character, the secondary 3 of the transformer T, which supplies the input circuit, would ordinarily be carried on the locomotive, and the track rails would ordinarily constitute the primary 4 of this transformer. The output circuit J may supply current to an electro-responsive

Lee uses a ladder shaped core with 4 legs. This is not suitable for a clamp-on DC Ammeter.

Moreover, Lee uses direct current to control alternating current. Lee does not mention "error correction", "measure", "sensor", or "increased SNR". He offers no teaching for making "an improved sensor" with less "zero offset" to better measure DC.

~~109~~ ~~56~~ 64

3-28-03

Lee does not anticipate Swain because Lee does:

not show the method or elements of Swain;

not teach the structure of Swain;

not teach or suggest all the claim limitations of any of Swain's generic claims 45, 63, 64, 65, and 66. For example, Lee lacks the teaching and structure of Swain 1995 in his claim 45:

An improved sensor, (element 1)
an operating parameter Q (element 10)
Essential Characteristic (element 7)
Means enabling (element 11)
substantially increase said SNR (element 12)

Moser, et al

Wilhelm Moser and Hans Dansel teach a way to "...Control the output volume of a radio receiver..." No mention is made of the above elements in claim 45. Nor is any mention made of the elements in claim 66, shown below, on page 126 of section 8.66

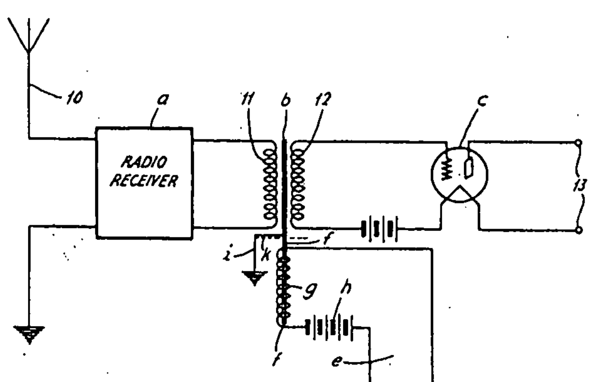
a more accurate sensor (element 1)
error correction (element 21)
measure (line 2)
error producing interference N is mostly removed (element 37)

Moser uses direct current (battery h, resistor d) in winding g to control the output 13. In contrast, the emphasis of the present invention is to measure direct current more accurately.

June 29, 1937. W. MOSER ET AL 2,085,440

VOLUME CONTROL DEVICE

Filed Oct. 16, 1935



It is often desirable to control the output volume of a radio receiver from a point located at some distance from the receiver. This is especially true in using receivers in airplanes, automobiles and other situations where it is desirable that the receiver be located in an inaccessible place in order to conserve space. It is accordingly an object of our invention to provide such a volume control which is simple in construction and operation and inexpensive to install.

It is a further object of the invention to provide a volume control in connection with a transformer which feeds into an audio frequency amplifier and in which a separate winding is provided about a portion of the transformer core, provision being made for passing a direct current through this winding and controlling the direct current by a variable resistor mounted near the receiver or at a location removed therefrom.

operator. When located at a point remote from the receiver the resistor is connected to the battery and winding g by a pair of long leads e.

An advantage of the arrangement is that the line e may have any desired length without detriment to the operating performance of the receiver. In this connection we preferably provide a ground connection i to the transformer core and (or) to provide a grounded static shield K between winding g and the transformer windings. Also, in accordance with the invention, the voltage source h may also be used as the source of filament and plate current of the amplifier tubes.

Having described our invention, what we claim as novel and desire to secure by Letters Patent is:

1. In a volume control device, the combination of a transformer having a core of magnetic material and primary and secondary windings, a third winding inductively coupled to said core, means

6-18-97

Swain's structure is lacking. Moser does not have elements of claims 45 and 66. He also lacks claim 64 elements: Moser

lacks a more accurate implement for measuring;

lacks an essential characteristic type sensor;

lacks an operating parameter Q;

lacks a sensor with an SNR which changes a lot when the magnitude of said operating parameter is modulated over a practical range.

Moser et al do not anticipate Swain because Moser does:

not show the method or elements of Swain;

not teach the structure of Swain;

not teach or suggest all the claim limitations of any of Swain's generic claims 45, 63, 64, 65, and 66, or for that matter, any of claims 32-66.

<u>Hubbard</u>

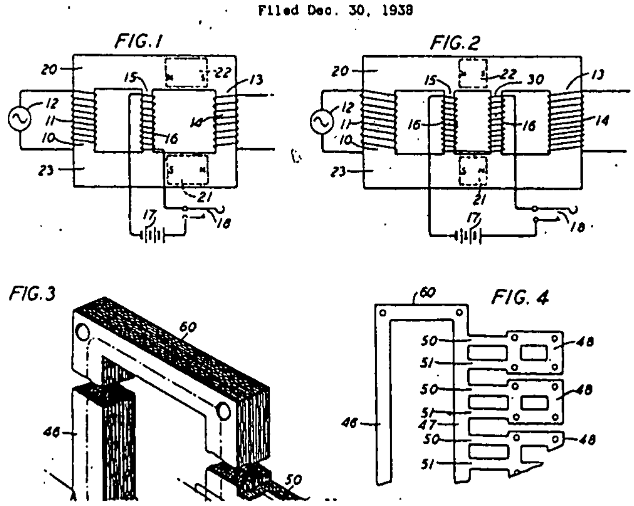
As with Sweeny, Lee, Moser, and Swain, Mr. Francis A. Hubbard shows none of the elements of Swain 1995 for making an "improved sensor" with which to "substantially increase said SNR". (Element 12 - claim 45).

Hubbard teaches a core having at least 3 legs used for switching alternating current telephone circuits using direct current. He does not measure anything. He uses direct current to switch alternating current telephone lines from one circuit to another.

Oct. 22, 1940. F. A. HUBBARD 2,218,711

ELECTRICAL SWITCHING DEVICE

Filed Dec. 30, 1938



This invention relates to electrical switching and particularly to alternating-current circuit controlling devices whose switching functions are performed inductively, thus obviating the need for circuit controlling contacts.

It is the object of this invention to provide an improved circuit controller of the type which functions to effectively control circuits without the use of circuit controlling contacts.

This object is attained in accordance with a feature of the invention by utilizing, in a circuit controller, a magnetic core structure of permalloy or similar alloy, which can be readily saturated by a steady field and which, when so saturated, becomes virtually non-magnetic to an alternating magnetomotive force of moderate intensity.

Another feature of the invention resides in the use of small permanent magnets embedded in the magnetic core which serve to normally saturate the core structure at particular points in the magnetic circuit, thereby effectively magnetically isolating those portions of the core which are separated from each other by the permanent magnets. By this arrangement a normal condition of substantial electrical uncoupling is maintained between input and output coils carried on separate legs of the magnetic core, which condition may be altered to effectively couple the input and output coils by passing direct current through a control winding carried by an intermediate leg of the core structure in such an amount as to saturate it and in the proper direction to oppose the saturating flux generated by the permanent magnets.

4-18-03

Swain's structure is lacking. Hubbard does not have elements of claims 45 and 66. Nor does he have elements of claim 65: Hubbard

lacks a more accurate sensor with implement for measuring;
lacks a sensor with a strong essential characteristic;
lacks an operating parameter of magnitude Q;
lacks an error reduction form of said implement, filled to support said sensor.

Hubbard does not anticipate Swain because Hubbard does:

not show the method or elements of Swain;
not teach the structure of Swain;
not teach or suggest all the claim limitations of any of Swain's generic claims 45, 63, 64, 65, and 66.

The cited references do not anticipate Swain 1995.

Sweeny

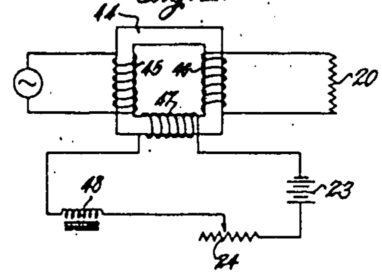
Charles P. Sweeny teaches a motor speed control. And not one word is written about "error correction" or "measurement". Instead he speaks of a polyphase source of AC power, a variable voltage transformer, and controlling the speed of a motor. Excerpts are shown below.

Jan. 7, 1941. C. P. SWEENY 2,227,468

VARIABLE VOLTAGE TRANSFORMER

Filed Aug. 31, 1938

Fig. 4.



Page 2

A still further modification of the variable voltage transformer is shown in Fig. 4. In this figure a conventional transformer 44 is shown upon which relatively widely spaced primary and secondary windings 45 and 46, respectively, are positioned. A single control winding 47 is shown for varying the saturation of the core 44. It will be noted that the alternating current flux in the core 44 will induce voltages in the control winding 47 such that the transformer of Fig. 4 is not suitable for use where alternating current voltages in the control circuit would be deleterious.

Page 3

Alternating currents in the control circuit can, however, be largely eliminated by employing a large inductance 48 in the control circuit.

Variable voltage transformers and systems herein described are capable of general application and may be employed wherever it is desired to vary an alternating current effective voltage in response to amount of current or frequency of current flowing within the control circuit. It will be appreciated that the present systems may be applied to polyphase circuits as well as single phase circuits. The systems herein disclosed are distinguished from conventional reactor circuits particularly in the fact that the effective voltage across the load is decreased with increase of control current, whereas in reactor circuits the effective voltage across the load is increased with increase of control current.

4-18-03

Combiner Species

Present claim 45 is for an improved sensor (for measuring) a physical quantity with substantially increased signal to noise ratio (SNR). A preferred embodiment of the combiner species is my 1995 figure 11. Details are given on pages 32 to 36.

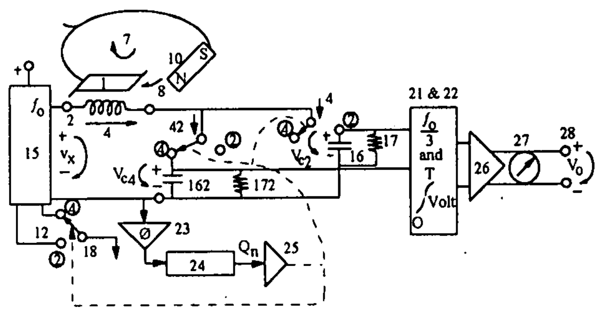


Fig. 11: A simpler implementation of the method defined in Eq. i).

These are entirely different devices. For example, Sweeny does not teach:

how to correct error,
how to measure, or
how to improve signal to noise ratio

Sweeny does not show elements in present claim 45:

a sensor (element 1),
constructed to have the Essential Characteristic (element 7),
an operating parameter Q (element 10)
means enabling said sensor to substantially increase said SNR in at least one of a machine, or independently (elements 11, 12, and 13).

Sweeny does not teach elements of claim 63:

a more accurate machine for at least one of measuring or controlling,
error producing interference N
a sensor
Said sensor has the essential characteristic that a change in said magnitude Q of said operating parameter causes a considerable change in the response of said output V to said interference N relative to the responsiveness of said output V to said input I,

support means.

Thereby considerably improving said machine's accuracy.

3-28-03

MPEP 2131 Anticipation

This section speaks of 35 U.S.C. 102(a), (b), and (e). It says:

MPEP 2131
Page 2100-62

TO ANTICIPATE A CLAIM, THE REFERENCE MUST TEACH EVERY ELEMENT OF THE CLAIM

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). "The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989). The elements must be arranged as required by the claim, but this is not an *ipsissimis verbis* test, i.e. identity of terminology is not required. *In re Bond*, 15 USPQ2d 1566 (Fed. Cir. 1990). Note that, in some circumstances, it is permissible to use multiple references in a 35 U.S.C. 102 rejection. See MPEP § 2131.01.<

The following shows that rejection based in whole or in part on Sweeny is improper.

Sweeny does not set forth the elements of Swain 1995. Not even when modified by the Examiner.

MPEP 2106 sets bounds on the freedom of the Examiner to dissect a claimed invention to isolate an element, and then find anticipation in a reference. The claim as a whole must be considered.

MPEP 2106
Page 2100-8

Finally, when evaluating the scope of a claim, every limitation in the claim must be considered. Office personnel may not dissect a claimed invention into discrete elements and then evaluate the elements in isolation. Instead, the claim as a whole must be considered. See, e.g., *Diamond v. Diehr*, 450 U.S. at 188–89, 209 USPQ at 9 ("In determining the eligibility of respondents' claimed process for patent protection under 101, their claims must be considered as a whole.

Sweeny and the Examiner's Magnet

With regard to cited reference Sweeny, the Examiner proposes to add a magnet; even though no magnet is in the Sweeny teaching.

3-28-03

8.45

Examiner Page 3 Line 4-7

> Looking at figure 4 of Sweeny, as an example, winding 45 senses a current applied by the source connected to winding 45. Winding 46 responds to the flux in the core 44 and produces a voltage that is applied to resistance 20. If a magnet were placed adjacent the core 44 it would cause undesired interference or "noise".

Sweeny teaches no magnet. Moreover, it would add "undesired interference" to Sweeny. This makes Sweeny figure 4 less useful. Since claims 32 to 66 were rejected on grounds of 35 U.S.C. 102(b), how can the Examiner add a magnet to Sweeny in trying to show anticipation?

The Examiner asserts:

Examiner Page 3 Line 11-14

> In figure 4 of Sweeny winding 47 applies a direct current bias to the core 44 which will change the signal-to-noise ratio. Moving the tap of variable resistor 24 in a first direction will increase the signal-to-noise ratio and moving the tap in the opposite direction will decrease the signal-to-noise ratio.

The Examiner does not say how much. Sweeny lacks "SNR is substantially altered" (claim 45, element 8). Sweeny teaches nothing like my figure 5 on page 58. This shows double the SNR.

The Examiner gives "no basis in fact"... as required by MPEP 2112.

MPEP 2112

EXAMINER MUST PROVIDE RATIONALE OR EVIDENCE TENDING TO SHOW INHERENCY

>The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. *In re. Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993)(reversed rejection because inherency was based on what would result due to optimization of conditions, not what was necessarily present in the prior art); *In re Oelrich*, 666 F.2d 578, 581–82, 212 USPQ 323, 326 (CCPA 1981).<

"In relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art." *Ex parte Levy*, 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990)

Sweeny uses winding 47 and resistor 24 to control the output of his variable transformer. Sweeny does not mention or infer SNR. Taking winding 47 and resistor 24 from control and using it to supposedly change SNR negates the usefulness of Sweeny.

MPEP 2143.01 opposes this.

THE PROPOSED MODIFICATION CANNOT CHANGE THE PRINCIPLE OF OPERATION OF A REFERENCE

If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349

MPEP 2143.01

THE PROPOSED MODIFICATION CANNOT RENDER THE PRIOR ART UNSATISFACTORY FOR ITS INTENDED PURPOSE

If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d

The Examiner's assertions lack proof in either Swain or Sweeny. Statements made without backup of experimental evidence or a solid reference amount to suppositions of what may happen. This is not sufficient for anticipation in the light of MPEP 2112.

MPEP 2112
Page 2100-47

EXAMINER MUST PROVIDE RATIONALE OR EVIDENCE TENDING TO SHOW INHERENCY

>The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993)(reversed rejection because inherency was based on what would result due to optimization of conditions, not what was necessarily present in the prior art); *In re Oelrich*, 666 F.2d 578, 581–82, 212 USPQ 323, 326 (CCPA 1981).<

"In relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art." *Ex parte Levy*, 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990) (emphasis in original) (Applicant's invention was

The Examiner asserts:

> Applicant has stated in his specification that changing the bias on a saturable core device will change the signal-to-noise ratio.

This is not true.

Besides, how would he use the Essential Characteristic if he had it? "Means enabling" and "substantially increase said SNR" (claim 45 elements 11 and 12) are not taught by Sweeny. He teaches no implement like my figure 9 on page 62.

4-18-03

Orthogonal Modulation Required

The examiner may have misunderstood my use of an orthogonal field and reluctance modulation to change the signal-to-noise ratio (SNR) of a Hall device.

Orthogonal field is discussed in my 1995, pages 28 and 38. This is a magnetic field perpendicular to the plane of the core in the Hall device I modified. Thus it changes reluctance without injecting a field around the loop, which would act as an erroneous signal input, and make trouble.

The Examiner uses an in-line field which would be a signal. This does not necessarily produce a SNR change, especially a 2 to one change.

A preferred variable reluctance method was given in my 1995 figure 12, shown below. Figure 12 is discussed on pages 39 and 40 of my 1995 teaching.

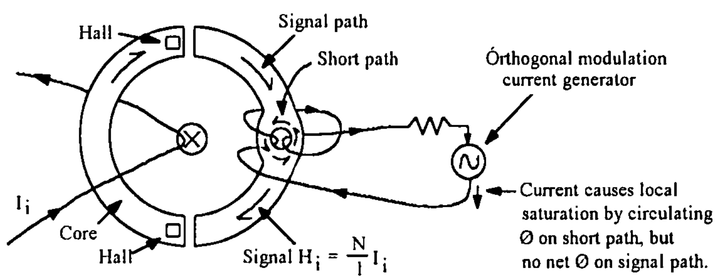


Fig. 12: Proposed core structure and magnetic reluctance selective modulation means for a Hall type clamp-on DC ammeter.

This is a form of orthogonal field which can sometimes - not always- be used to modify SNR. Both of my orthogonal fields are entirely different from the examiner's proposal, and from Sweeny's patent.

Even if the combination of the examiner's proposal and Sweeny could be used and made to work, it could not be used against Swain 1995, because the examiner found the idea in Swain 1995, not Sweeny.

The Examiner again asserts without proof:

Examiner Page 3 Line 19-20
Examiner Page 4 Line 1-4

> The apparatus of Sweeny has Applicant's essential characteristic in that if a magnet were placed adjacent the core 44 in a position to produce a field in the core 44 opposite in direction to the direction of the field produced by winding 47 increasing the field produced by winding 47 would negate the effect of the magnet and improve coupling of the signal source to the load 20. What Applicant calls signal to noise ratio would be improved.

4-18-03

Enough to be useful? The Examiner gives no "basis in fact". How can the Examiner know? He needs a definition of SNR like my claim 45:

SNR defined

Claim 45
Line 10

$$SNR = \frac{\delta V / \delta I}{\delta V / \delta N}, \text{ where}$$

Using lines 4-13 I calculated the SNR of 5" clip #88 and got 13 to 29 using measured data. This is shown in figure 5. Yet the Examiner wrote:

Examiner 1-29-03
Page 3, Line 7-8

Lines 4-13 of claim 45 deal with definition of signal-to-noise ratio and are not considered to add substance to claim 45.

I do not agree. I think this SNR definition can be used to separate a useful device from a theory lacking basis in fact.

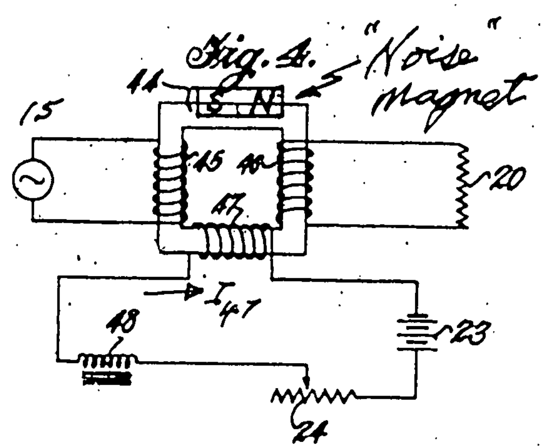
I operated 5" clip #88 with an implement like figure 11 and used my claim 45 definition to measure an SNR benefit ranging from 3 to 20 (page 36, Line 20). This is useful. The Examiner has not shown measured utility using Sweeny figure 4.

Moreover, Sweeny lacks elements "substantially altered", "means enabling", and "substantially increase said SNR". These are claim 45 elements 8, 11, and 12.

Furthermore, the Examiner combined Sweeny with a magnet never even inferred in Sweeny. He stated without proof what-at-best may happen. There is no evidence that it necessarily will happen.

For clarity, I have placed the Examiner's magnet on core 44 in figure 4:

Sweeny figure 4
plus
Examiner's page 3
Line 19



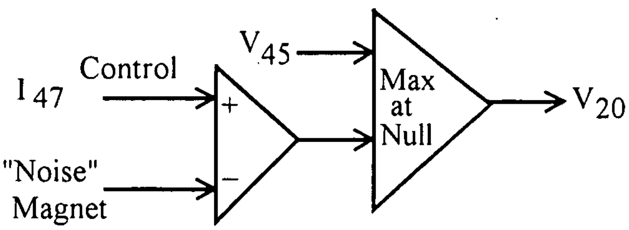
4-21-03

8.45

The Examiner's field is in line with the core - a control winding field - not an orthogonal field. Swain teaches orthogonal fields in connection with the Hall device and figure 12. The operating parameter of the claims acts orgonally - it multiplies. It does not add an in line signal.

The Examiner's line 21-22 increases I 47 to negate the effect of the magnet. This will increase the ability of AC power source 15 to deliver power to load 20, but there is no experimental evidence to show that SNR is improved.

The magnet "noise" is now differentially connected with the control input I 47, so moving the core 4 with respect to the magnet will require an equal and opposite adjustment of control input I 47 to maintain the same output to load 20. The block diagram is:



The control and noise inputs have a differential or subtract function, not selective modulation. The output V20 is greatest when I 47 - noise = 0; i.e., null.

In contrast, claim 45 teaches a selective modulation. This has been shown by experiment - the data is plotted in figure 5 - to substantially increase SNR in 5" clip #88. In selective modulation the relative sensitivity of the sensor output V to signal and noise is changed by the operating parameter Q. Figure 13 shows this.

1995 page 66, figure 13

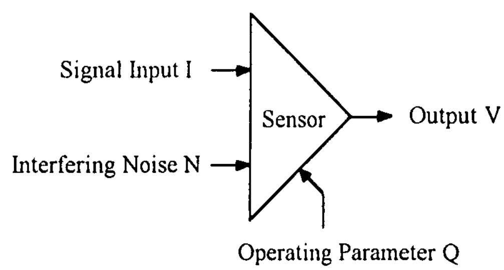


Fig. 13. General representation of a Sensor described in Eq. a) thru Eq. j).

Part of both inputs I and N go through to output V, but how much is set by the operating parameter Q. This is made clear in the DISCOVERY.

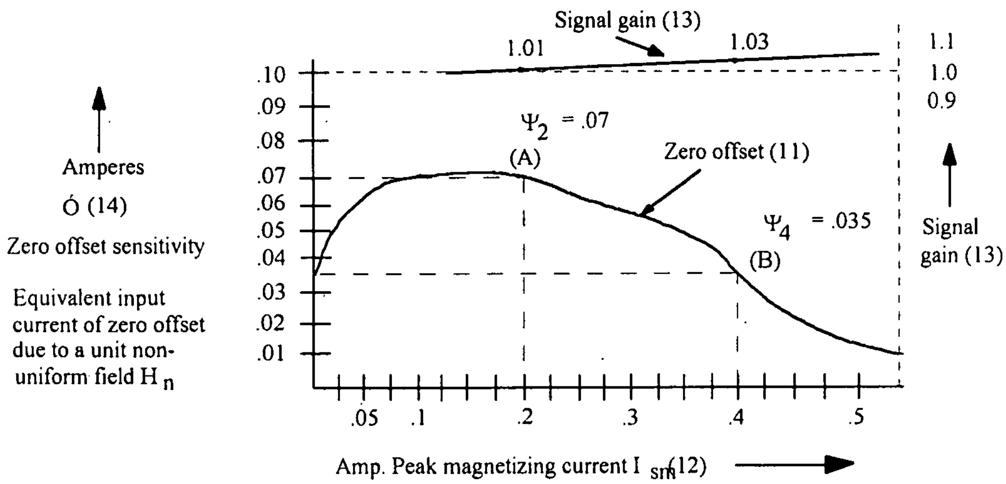
DISCOVERY

1995 page 11 The inventor discovered that the output V of many Swain Meter clamps was a lot less sensitive

Line 11-13 (1/2 to 1/3 in some sensors) to a change in the intensity of a non-uniform magnetic field H_n when the magnitude of an operating parameter I_{sm} was doubled or tripled. And the sensitivity (gain) to a change in signal input current I stayed constant to within a few percent.

4-21-03

Experimental data showing quantitatively the degree of selective modulation obtained is shown in figure 4.



1995 page 57
Figure 4

Fig. 4

Normalized Signal Gain (g) vs. I_{sm}
and
Normalized Zero Offset from H_n vs. I_{sm}
for
Five inch diameter aperture sensor #88.

The Examiner's proposal to modify Sweeny is not orthogonal. It does not give a quantitative result. It does not teach the elements and structure of claims 45 and 66; or 32-66 for that matter. It does not anticipate Swain's claims.

4-22-03

8.45

Structure of Claim 45 for the Essential Characteristic Contrasted with the Structure of Swain 1970.

Summary

The Essential Characteristic shown by the sensor used as an example in my 1995 Application was the result of the construction of the 5" clip #88 itself.

I was able to demonstrate a substantial increase in signal to noise ratio - SNR - because of the construction of the "means enabling" which drove the Operating Parameter I_{sm}.

The disclosure shows that the 5" clip #88 was:

Big;

It had a lot of fine steel placed carefully on the aluminum core;

It had a lot of copper. The winding N_s had 1000 turns of #22 wire. This kept the winding resistance down to about 3 ohm.

The "means enabling" - SN 2336; for error reduction was built to drive the Operating Parameter I_{sm} to a high of 0.4 Amperes and for error correction it was built to cycle I_{sm} down to 0.2 Amp, switched, divided, combined, etc.

An example of a 1995 "means enabling" for error correction is figure 9.

Figure 9, 1995, page 62

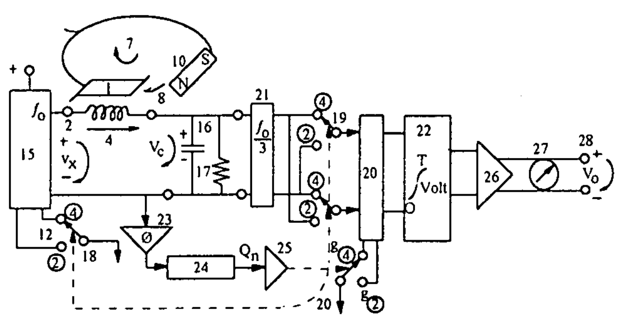


Fig. 9: A switching implementation of the mathematical relationship shown in Eq. i).

Construction and test results are given on pages 32-36.

~~457~~ 76

4-21-03

The disclosure is antecedent for claim 45 by virtue of 35 U.S.C. 112, paragraph 6:

35 U.S.C. 112, Par 6
Page L-14

> An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.
>
> (Amended July 24, 1965, Public Law 89–83, sec. 9, 79 Stat. 261; Nov. 14, 1975, Public Law 94–131, sec. 7, 89 Stat. 691.)

Compared with my 1995 five inch clip #88, the clips I described in my 1970 application for Patent 3,768,011 were:

Smaller by a factor of up to 20;

Used far less steel of a different part number. It was less by a factor of up to 36, and it was not nearly as well laid up on the core.

The winding N_S had less turns, by a factor of up to 10.

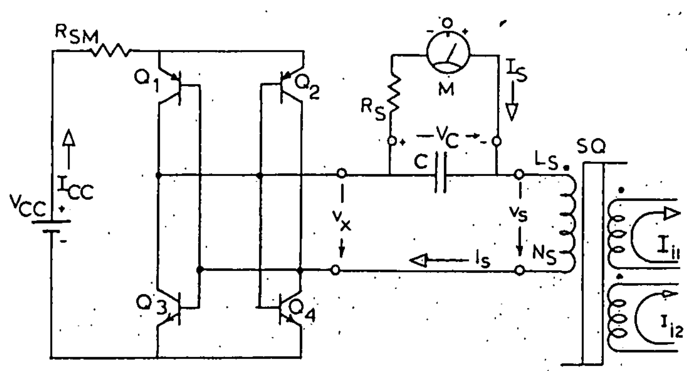
The inverter was built to drive a smaller peak magnetization current I_{sm} by a factor of up to 8.

Since the Essential Characteristic and the rest of the present invention were unknown in 1970, there was no error reduction or error correction of zero offset error due to non-uniform magnetic fields, H_n. I_{sm} was not switched. There was no divider, combiner, etc.

The peak magnetizing ampere turns was far less, by a factor of up to 80.

Figure 2 below shows an inverter for Swain 1970.

Swain 1970
Patent 3,768,011
Figure 2



The combined effect of the contrasting construction between claim 45 and Swain 1970 is a difference of orders of magnitude, i.e., a difference of kind. Therefore the Examiner was in error when he wrote:

4-21-03

Examiner Final Rejection of 1-29-03, page 3 Line 16-17

Swain uses the same kind of core material as used in the present application and will thus inherently have the "essential characteristic".

It is unlikely that the 1970 clips had enough of the Essential Characteristic to be useful. No one knew how to test it. And even if they had a little, no one knew how to make the "means enabling" which is necessary for the Essential Characteristic to be of any practical use.

Therefore, Swain 1970 did not anticipate claim 45 of Swain 1995 in the manner required by MPEP 706.02.

MPEP 706.02 Page 700-10

DISTINCTION BETWEEN 35 U.S.C. 102 AND 103

The distinction between rejections based on 35 U.S.C. 102 and those based on 35 U.S.C. 103 should be kept in mind. Under the former, the claim is anticipated by the reference. No question of obviousness is present. In other words, for anticipation under 35 U.S.C. 102, the reference must teach every aspect of the claimed invention either explicitly or impliedly. Any feature not directly taught must be inherently present.

The following sections of my 1995 application and my 1970 application are basis for the above assertions.

Structure for Claim 45

I have underlined 13 elements in claim 45. Antecedent will be found for some in the 1995 disclosure. This will be contrasted with Swain 1970, which does not mention or infer these.

Annotated claim 45

Line | Element #

Claim 45 (amended)

An improved Sensor — 1

having an output V responsive to a physical quantity I, and also — 2, 3

responsive to an undesired interference N, — 4

the ratio of — 5

the said responsiveness of the said output V to said physical quantity I

in relation to

the said responsiveness of said output V to said interference N

being defined as the Sensor's signal to noise ratio SNR, — 6

which can be stated in symbolic form:

$$SNR \equiv \frac{\delta V/\delta I}{\delta V/\delta N}, \text{ where}$$

4-21-03

Claim 145- Contd.

δV is a change in said output V,

δI is a change in said physical quantity I, and

δN is a change in said interference N; and also

said Sensor is constructed to have the Essential Characteristic that the said signal to noise ratio SNR is 7

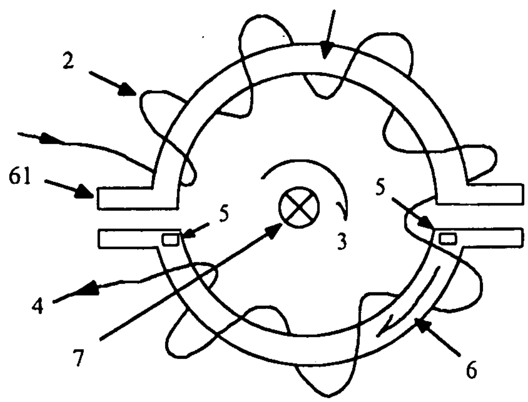
substantially altered by Selective Modulation of an Operating Parameter Q, and 8, 9, 10

means enabling said Sensor to substantially increase said SNR in at least one of: 11, 12

a Machine, or independently. 13

Structure of 5" Clip #88

Sensor (element 1) "is constructed to have the Essential Characteristic" (element 7). The example in the disclosure is 5" Clip #88. Construction is shown in figure 1.



1995 page 1
Figure 1

Fig. 1: A clamp-on sensor

The construction of 5" Clip #88 is described on page 12.

Page 12, line 3-14

The data in Fig. 4 shows the approximate behavior of 5" dia. aperture clip #88. It uses concepts shown in Patent 3,768,011, especially in connection with Fig. 2 and Fig. 4 therein. Clip #88 is outlined in Fig. 1 herein. The primary parts are:

A core SQ (1) having five layers of 0.725" wide-4D low reluctance steel from Magnetics Inc. of Butler, PA.,

The core is mounted on a support and arranged so that the magnetic reluctance around the full magnetic path is minimized. Care should be used to avoid forcing or bending the steel because stresses and strain may produce a poorer core.

A uniform coupling sense winding N_S (2) of about 1000 turns of #22 magnet wire. A symmetrical and balanced form is preferred. The winding resistance should be less than 5 ohms.

Half inch lips (61) which are constructed to mate well so that the magnetic reluctance all around the core is minimized.

The cross sectional area of the steel core is .0145 square inches.

3-24-03

8.45

Operating parameter (element 10 in claim 45) I_{sm} is either 0.2 or 0.4 Amp peak in means enabling (element 11) figure 9. This represents SN 2336.

Structure of Means Enabling

1995, page 62, Figure 9

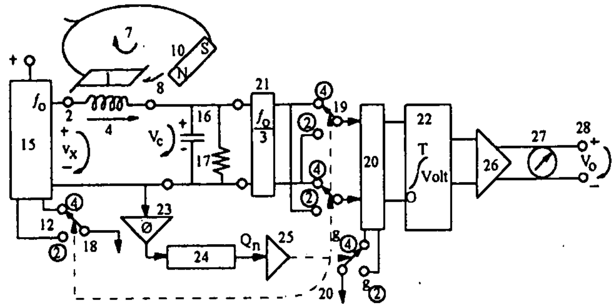


Fig. 9: A switching implementation of the mathematical relationship shown in Eq. i).

Figure 9 includes means enabling (element 11) switches, filters, dividing and combining. The component values, sequence of operations, etc. are given on pages 32-36. Samplings appear below.

1995 page 32 Line 17-23

In Fig. 9 the special inverter 15 operating at frequency f_0 is series connected with the sensor's coupling sense winding 2 and the parallel combination of capacitor 16 and resistor 17. Input current 7 influences the magnetic material in the core 1, and so also does the magnet 10. So the average current 4 in the loop produces a voltage V_c across capacitor 16 and resistor 17 which is proportional to the input current 7, and also proportional to the effect of noise magnet 10 and its non-uniform field 8. In this implementation, the means driving the operating parameter I_{sm} (12) from 0.2 to 0.4 Amp. is an electronic switch 18.

1995 Page 33 Line 9-25

In Fig. 9, state change is governed by the phase shifter 23, counter 24, which goes $Q_n = 2^n$ counts before changing the gate, and the gate or switch driver 25. All switches are driven by gate 25. Phase shifter 23 driven by inverter 15 and voltage v_x clocks the counter 24 at about halfway through one half of one cycle of inverter 15. This causes the counter to drive the gate to a new A state near the middle of a half cycle when inverter instantaneous current (i_s) 4 is near zero, not at a start or finish of a half cycle of the inverter where the inverter current (i_s) 4 is at a maximum.

In the A state, operating parameter I_{sm} 12 is reduced from 4 to 2, the polarity switch 19 goes to (-) or negative, and the gain is reduced by switch 20. The A state is marked as the 2 position on all switches.

In both the A and B states, the gain control 20 drives the voltage V_c through to the

3-24-03

integrator 22, which averages the signals from both states over a number of gate cycles to get the error corrected signal to the input of amplifier 26. The output of amplifier 26 is error corrected, and applied to meter 27 (analog +/or digital) and to the output terminals 28 where the corrected output is V_0.

In Fig. 9 the noise due to magnet 10 and interfering field (H_n) 8 is canceled by the process of: during B, add positive full signal and the small noise Z_4 and then during A, subtracting half of

Test results for the preferred means enabling (element 11) which is figure 11 on page 64 are included on page 36.

1995 Page 36 Line 11-21 Capacitor 16 is 470 μF, as is capacitor 162. Resistor 17 is 200 ohms, but resistor 172 is 100 ohms. The counter Q_n is set for 2^5, where n = 5. The integrator 22 has a cutoff frequency of about 1 Hz.

The implementation SN 2336, outlined in Fig. 11, runs on 12 volts with f_0 roughly equal to 400 Hz and satisfies the requirements of the mathematical relation shown in Eq. i) with a gain ratio $\eta = 2$. Eq. i) is the general method, given in the general method section.

When tested with a non-uniform magnetic field H_n from a nearby speaker magnet, the zero offset error was one ampere equivalent input under the previous conditions not using this invention. The noise or zero offset error in the corrected output was generally less than ± 0.1 Amp. equivalent input current. This is a ten to one benefit. The benefit is usually 3 to 20. Positioning the magnet nearer the side of the clip gave better results than when the magnet was

The benefit of 10 to one is antecedent for claim 45 (element 12) "substantially increase said SNR".

These excerpts from the disclosure show that claim 45 has antecedent in an improved sensor (element 1), constructed and tested with means enabling (element 11) to show a ten to one overall improvement in signal to noise ratio SNR (element 6) in the presence of interference from a non-uniform magnetic field H_n (element 4).

<u>Contrast with Swain 1970</u>

This is in contrast with Swain 1970, which did not show all of the claim 45 elements in either the sensor or the means enabling.

4-21-03

8.45

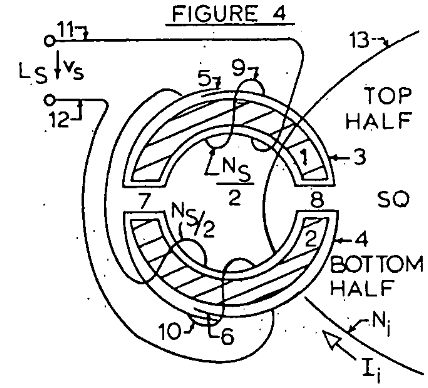
Structure for Swain 1970

Clip

The structure of a 1970 clip is shown in figure 4.

Swain 1970
3,768,011
Figure 4

FIGURE 4



Construction is described in column 15.

Ibid, Column 15
Line 14-29

solve 1 milliampere direct current on a ± 50 ma full-scale instrument is shown in FIG. 4. Two half sections 1 and 2 of cylindrical tube having 0.5 inch outside diameter, 0.25 inch inside diameter, and 0.45 inches length, and made of relatively non-conducting and reasonably rigid material, such as plexiglass or Poly Vinyl chloride (PVC) are wound with one or more layers of square loop tape 3 and 4. Such a tape is found within the case of a toroidal core manufactured by Magnetics, Inc., of Butler. Pa., and designated 50094-1D. A single layer is preferred. The overlaps 5 and 6 are preferably ⅜ inch. The length of the cylindrical tube sections 1 and 2 is preferably a little more than the 0.4 width of the tape 3 and 4. The square loop tapes 3 and 4 may be held in place with insulating adhesive tape wound overall.

Compare Swain 1970 with Swain 1995

The size, relative to 5" clip #88, is $\frac{.25}{5}$, or $\frac{1}{20}$. The cross sectional area is .0004 square inches. This area, relative to 5" clip, is $\frac{.0004}{.0145} = \frac{1}{36}$

The winding N_S is also stated:

Ibid, Column 15
Line 45-52

The two windings 9 and 10 each have 50 turns of 36 Anaconda HAN magnet wire. They are series-connected, so $N_S = 100$. The windings are made as uniform and symmetrical as feasible to optimize noise concellation. The total ohmic resistance R_S is about 5 ohms at lead wire pair ends 11 and 12. In use, these connect to terminals V_S in FIG. 2. The operating period T_0 is then 180 microseconds.

4-21-03

The number of turns N_S is 100. This, relative to 5" Clip #88 is $\frac{100}{1000} = \frac{1}{10}$

The magnitude of the peak magnetization current is I_{sm} = 50 mA.

Ibid, Column 7
Line 60-62

> The maximum current threshold I_{SM} is very nearly I_{CC} because the base current required to saturate a complimentary pair is much less than 50 ma.

This I_{sm} compares with that for 5" Clip #88: $\frac{50 \text{ mA}}{400 \text{ mA}} = \frac{1}{8}$.

The peak magnetization ampere turns compares with 5" clip #88:

$$\frac{(50 \text{ mA})(100 \text{ turns})}{(400 \text{ mA})(1000 \text{ turns})} = \frac{5}{400} = \frac{1}{80}.$$

The combined effect of the differences in sensor clip construction between 1970 and 1995 is orders of magnitude. This amounts to a difference in kind.

It is unlikely that Swain 1970 clips had enough of the Essential Characteristic to be useful. Therefore, the Examiner was in error to write:

Examiner, 1-29-03
Page 3, Line 16-17

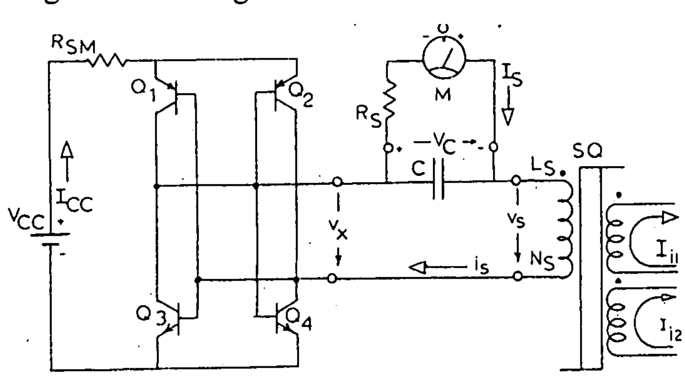
> Swain uses the same kind of core materials as used in the present application and will thus inherently have the "essential characteristic".

Moreover, in 1970 there was no means enabling (element 11) fitted to selectively modulate (element 9) an operating parameter Q (element 10), so the Essential Characteristic (element 7) could not be tested. Nor could it be used, if there, because there was no means enabling (element 11) to substantially increase said SNR (element 12).

Structure of the Means Enabling

The Swain 1970 means enabling is shown in figure 2.

Swain 1970
3,768,011
Figure 2



4-21-03

Swain 1970 had a bad magnitude I_{sm}.

The inverter of figure 2 worked at operating parameter I_{sm} = 50 mA. It could be modified for I_{sm} = 150 mA. This is in the middle of the high noise sensitivity (Ψ = .07) sector on figure 4.

So even in the unlikely event that the 1970 clip had some of the Essential Characteristic, it would have been operated in the unstable (I_{sm} less than 50 mA) regions, or in the high noise sensitivity regions of the operating parameter I_{sm}.

Swain 1970 Means Enabling lacked Structure of Swain 1995

Moreover, when compared with 1995 means enabling figure 9, Swain 1970 means enabling lacked many elements of structure:

Test sensor for points (A) and (B) in figure 4
I_{sm} = 400 mA
switching to I_{sm} = 200 mA
state switching
division
combining
timing

These elements are all absent in Swain 1970, and present in 1995 claim 45 as read in the light of the disclosure.

Swain 1970 did not anticipate Swain 1995

Therefore Swain 1970 does not anticipate Swain 1995 because:

a) Swain 1970 lacked a useful Essential Characteristic structure, and
b) Swain 1970 lacked the means enabling structure to operate, i.e., use the Essential Characteristic.

4-21-03 cl

8.66 Traverse of the Examiner's Final Rejection of Claims 32-66 based on the fact that Elements in Claim 66 are not in the Cited References.

Summary

Claim 66 is for a:

a) a method for solving the discovered problem - interference noise N - from a non-uniform magnetic field H_n.

b) a method for constructing sensors with the Essential Characteristic.

c) a method for building and adjusting and implement for operating said sensors to get more accurate results.

After 3 years of not having examined on merit generic apparatus claims 63 and 65, and also not having examined on merit generic method claims 64 and 66, the Examiner stated:

Examiner page 3
Line 1-2

5. Claims 32-66 are rejected under 35 U.S.C. 102(b) as being fully anticipated by any one of Lee, Moser et al, Hubbard, Sweeny or Swain.

The Examiner writes only of claim 45, despite the fact that not one of the 5 cited references meets the requirement of MPEP 706.02 as claimed in generic method claim 66.

MPEP 706.02
Page 700-10

DISTINCTION BETWEEN 35 U.S.C. 102 AND 103

The distinction between rejections based on 35 U.S.C. 102 and those based on 35 U.S.C. 103 should be kept in mind. Under the former, the claim is anticipated by the reference. No question of obviousness is present. In other words, for anticipation under 35 U.S.C. 102, the reference must teach every aspect of the claimed invention either explicitly or impliedly. Any feature not directly taught must be inherently present.

Moreover, claim 66 must be read in the light of the disclosure.

MPEP 2106
Page 2100-8

The plain and unambiguous meaning of paragraph six is that one construing means–plus–function language in a claim must look to the specification and interpret that language in light of the corresponding structure, material, or acts described therein, and equivalents thereof, to the extent that the specification provides such disclosure. Paragraph six does not state or even suggest that the PTO is exempt from this mandate, and there is no legislative history indicating that Congress intended that the PTO should be. Thus, this court must accept the plain and precise language of paragraph six.

4-18-03

8.66

The 39 elements and other aspects of claim 66 presented in the light of the disclosure are not to be found in any cited reference. Therefore, claim 66 is not anticipated.

Annotated Claim 66

Line # — Element #

I claim a method for making a more accurate sensor with implement for at least one of measurement or control, made in steps: 1, 2

obtain a said sensor having an output V responsive to a physical quantity input I, the gain g given by 3, 4, 5

$$g \equiv \frac{\delta V}{\delta I}, \text{ and}$$

said output V is also responsive to an undesired error producing interference N, the sensitivity Ψ being 6, 7

$$\Psi \equiv \frac{\delta V}{\delta N}, \text{ and}$$

in addition, said sensor has an operating parameter of magnitude Q which modulates said Ψ, and to a lesser extent said gain g; 8, 9

at least one of calibrate, or make by a proven process, or otherwise assure that said sensor has a strong Essential Characteristic evidenced by observing that said Sensitivity Ψ changes a lot more than said gain g when said magnitude Q is driven over a practical range of values; 10, 11

and at least one of:

provide an error reducing form of said implement, fitted to support said sensor, and 12, 13, 14

also fitted to drive said magnitude Q and hold it at a constant value, and by at least one of 15, 16
measurement or a proven process, set said magnitude Q at a value corresponding to a said 17
sensitivity Ψ which is a lot less than heretofore while said gain g is still good, 18, 19
thus making said sensor with implement substantially more accurate than comparable transducers 20
for said input I in the presence of said interference N;
or;

provide an error correction form of said implement having an output V_c, and 21, 22
also fitted to support said sensor, and
further equipped with state means 23

~~178~~ ~~126~~ 85

4-15-03

Claim 66 - contd.

Line # Element #

driving said magnitude Q,

dividing the said output V, and 24

combining the said output V, and 25

wherein said combining is coupled to said implement output V_c; 26

construct the said state means so that there is at least one state "A" wherein 27

said means drive said magnitude Q to produce a large said sensitivity Ψ with good said gain g, 28
and also said sensor output V is largely said divided and made available for said combining; 29

further construct said state means so that there is also at least one state "ß" wherein 30

said means drive said magnitude Q to produce a small said sensitivity Ψ with good said gain g, 31
and
also said sensor output V is but slightly said divided and made available for said combining; 32

to get said error correction, at least one of:

set by a proven process, or adjust at least one of a said means dividing or said means combining 33, 34
so that

the said largely divided said large Ψ of said state "A" is about equal to and opposite from the said 35
but slightly divided said small Ψ of said state "ß", and
thereby the said Ψ's approximately cancel in said combiner so that 36
the said error producing interference N is mostly removed from said output V_c; and 37

not withstanding there is remaining at said V_c a large part of said responsiveness to said physical 38
quantity input I;

so that thereby said sensor with implement is a whole lot more accurate than comparable 38
transducers for said physical quantity input I in the presence of said interference N.

4-15-03 JJ

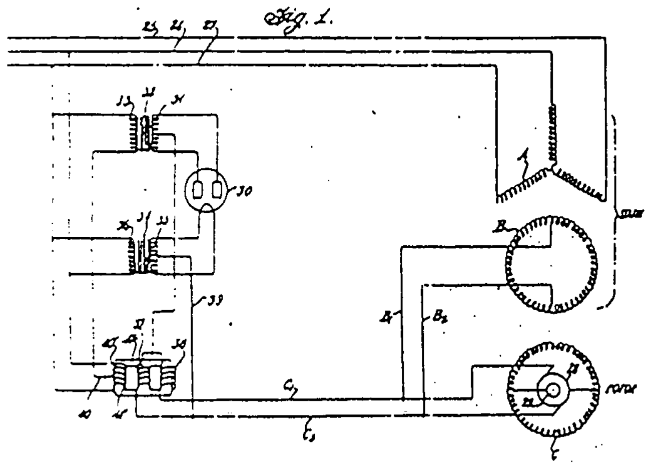
Sweeny

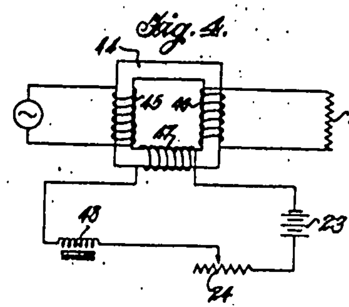
In paragraph 5, the Examiner writes mostly about cited reference Sweeny. Relevant excerpts are shown below.

Jan. 7, 1941. C. P. SWEENY 2,227,468

VARIABLE VOLTAGE TRANSFORMER

Filed Aug. 31, 1938





Page 2

A still further modification of the variable voltage transformer is shown in Fig. 4. In this figure a conventional transformer 44 is shown upon which relatively widely spaced primary and secondary windings 45 and 46, respectively, are positioned. A single control winding 47 is shown for varying the saturation of the core 44. It will be noted that the alternating current flux in the core 44 will induce voltages in the control winding 47 such that the transformer of Fig. 4 is not suitable for use where alternating current voltages in the control circuit would be deleterious.

Page 3

Alternating currents in the control circuit can, however, be largely eliminated by employing a large inductance 48 in the control circuit.

Variable voltage transformers and systems herein described are capable of general application and may be employed wherever it is desired to vary an alternating current effective voltage in response to amount of current or frequency of current flowing within the control circuit. It will be appreciated that the present systems may be applied to polyphase circuits as well as single phase circuits. The systems herein disclosed are distinguished from conventional reactor circuits particularly in the fact that the effective voltage across the load is decreased with increase of control current, whereas in reactor circuits the effective voltage across the load is increased with increase of control current.

In claim 66, element 1 is a more accurate sensor. In contrast, Sweeny teaches a variable voltage transformer for control of the speed of a motor.

Claim 66 Contrast

Claim 66 has a physical quantity input I (element 4) with gain (element 5) to the output V (element 5). But in figure 4 Sweeny has a "single control winding 47" (line 69). Sweeny does not mention other elements of claim 66.

Unmentioned Element	Element #
Undesired error producing interference N	6
Sensitivity Ψ	7
Operating parameter of magnitude Q which	8
modulates said Ψ, and to a lesser extent said gain g	9
at least one of calibrate, or make by a proven process, or	Line 11

4-15-03

otherwise assure that said sensor has a
strong essential characteristic as evidenced by observing that 10
said sensitivity Ψ changes a lot more than said gain g 11
when said magnitude Q is driven over a practical range of values Line 13

This is only the first 11 elements out of 39 in claim 66 which Sweeny lacks.

In his section 5, the Examiner makes iffy statements in an attempt to show that Sweeny teaches a sensor. Then he adds a magnet to figure 4:

Examiner 29 Jan 03. Page 3, Line 4-7	Looking at figure 4 of Sweeny, as an example, winding 45 senses a current applied by the source connected to winding 45. Winding 46 responds to the flux in the core 44 and produces a voltage that is applied to resistance 20. If a magnet were placed adjacent the core 44 it would cause undesired interference or "noise".

<u>Sweeny has no magnet</u>

This is contrary to Sweeny. No magnet is mentioned or inferred in Sweeny.

How can Sweeny anticipate Swain if the Examiner has to add the magnet which Swain taught?

Moreover, Sweeny powers winding 45 with the AC mains. He does not say or infer that he measures or senses anything. His control winding 47 (line 69) changes the effective voltage across the load (line 14-16).

In his section 5 the Examiner writes of SNR in Sweeny.

Ibid Line 11-14	In figure 4 of Sweeny winding 47 applies a direct current bias to the core 44 which will change the signal-to-noise ratio. Moving the tap of variable resistor 24 in a first direction will increase the signal-to-noise ratio and moving the tap in the opposite direction will decrease the signal-to-noise ratio.

The Examiner does not say how much. Sweeny lacks element "Ψ changes a lot more then said gain g" (claim 66, element 11). Sweeny teaches nothing like my figure 5 on page 58. This shows double the SNR.

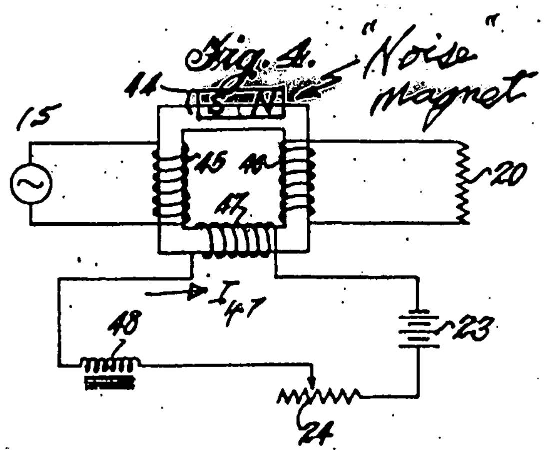
In addition, the Examiner offers no supporting evidence for this assertion.

4-18-03

8.66

For clarity I have placed the Examiner's "noise" magnet in Sweeny's figure 4:

Sweeny figure 4
plus
Examiner's magnet



Without supporting evidence, the Examiner asserts that changing resistor 24 will change signal to noise ratio (SNR). But the Examiner shows no useful result. Sweeny does not mention SNR.

Even if SNR were changed as the Examiner writes, he shows no way to make a useful device. Sweeny uses resistor 24 to change control current. Sweeny needs resistor 24 to control the effective voltage across the load (line 14-16). Therefore he is not free to set resistor 24 for SNR.

<u>Performance of Sweeny Damaged</u>

The Examiner proposes a "noise" magnet, and then using control winding 47 for a new purpose. This damages the performance of Sweeny - something which MPEP 2143.01 says cannot be done:

MPEP 2143.01

<u>THE PROPOSED MODIFICATION CANNOT RENDER THE PRIOR ART UNSATISFACTORY FOR ITS INTENDED PURPOSE</u>

If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984)

Without supporting evidence, the Examiner asserts that the Essential Characteristic would be present in Sweeny's apparatus, if the Examiner's magnet is added to figure 4 of Sweeny.

4-15-03

Ibid Line 19-20 Ibid, Page 4 Line 1-4	The apparatus of Sweeny has Applicant's essential characteristic in that if a magnet were placed adjacent the core 44 in a position to produce a field in the core 44 opposite in direction to the direction of the field produced by winding 47 increasing the field produced by winding 47 would negate the effect of the magnet and improve coupling of the signal source to the load 20. What Applicant calls signal to noise ratio would be improved.

Enough to be useful? There is no mention of SNR benefit like my "usually 3 to 20" on page 36.

Moreover, Sweeny lacks elements of claim 66 for using the Essential Characteristic (element 10) to make the sensor with implement a "whole lot more accurate" (element 39).

Sweeny lacks the "use" elements:
- "error reducing form of implement" (12)
- "substantially more accurate" (20)
- "error correction form" (21)
- "error producing intereference N is mostly removed from said output V_C" (37), and more and more.

In all this, the Examiner offers no proof other than the inaccurate statement:

Ibid, Page 3 Line 14-15	Applicant has stated in his specification that changing the bias on a saturable core device will change the signal-to-noise ratio.

The Examiner's Proposal is not Useful

I did not say this. I did show how to use orthogonal fields to modulate (multiply) sensitivity. The Examiner's proposal is iffy at best. The field of his magnet is in line with the control and input and output, so will likely add or subtract - not multiply. This is not useful. It is contrary to MPEP 2106.

MPEP 2106
II, A
Page 2100-5

A. Identify and Understand Any Practical Application Asserted for the Invention

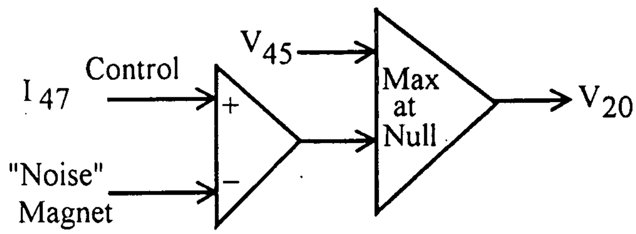
The subject matter sought to be patented must be a "useful" process, machine, manufacture, or composition of matter; i.e., it must have a practical application. The purpose of this requirement is to limit patent protection to inventions that possess a certain level of "real world" value, as opposed to subject matter that represents nothing more than an idea or concept, or is simply a starting point for future investigation or research (*Brenner v. Manson*, 383 U.S. 519, 528–36, 148 USPQ 689, 693–96 (1966); *In re Ziegler*, 992 F.2d 1197, 1200–03, 26 USPQ2d 1600, 1603–06 (Fed. Cir. 1993)).

4-18-03

A problem with the Examiner's page 4, line 1-2 is that it increases I 47 to negate the effect of the magnet. This will increase the ability of AC power source 15 to deliver power to load 20, but there is no experimental evidence to show that SNR is improved.

The magnet "noise" is now in line, or differentially connected with the control input I 47, so moving the core 4 with respect to the magnet will require an equal and opposite adjustment of control input I 47 to maintain the same output to load 20. The functional diagram is:

Functional Diagram -
Sweeny plus
Examiner's magnet



This makes Sweeny's variable voltage transformer more difficult to control.

The control and noise inputs have a differential or subtract function, not selective modulation. The output V20 is greatest when I 47 - noise = 0; i.e., null.

In contrast, claim 66 teaches a modulation (element 9): The relative sensitivity of the sensor output V to signal and noise is changed by the operating parameter Q. Figure 13 shows this.

The Examiner's assertions are "iffy" at best. This is not enough for basis for rejection of claims, per MPEP 2112:

MPEP 2112
Page 2100-47

EXAMINER MUST PROVIDE RATIONALE OR EVIDENCE TENDING TO SHOW INHERENCY

>The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993)(reversed rejection because inherency was based on what would result due to optimization of conditions, not what was necessarily present in the prior art); *In re Oelrich*, 666 F.2d 578, 581–82, 212 USPQ 323, 326 (CCPA 1981).<

"In relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art." *Ex parte Levy*, 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990) (emphasis in original)

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At best, the Examiner says what <u>may</u> happen. He gives no proof that what he says <u>necessarily</u> will happen.

<u>Claim 66 contrasted with Sweeny, the Examiner, and the other cited references</u>.

In contrast, claim 66, read in the light of my 1995 disclosure, is specific, analytic, shows experimental data, provides drawings for a useful device, and teaches how to build and adjust it to operate properly. Test results are given.

<u>Specific, with Experimental Data</u>

Claim 66 includes elements:	Element #
Gain g	5
Interference N	6
Sensitivity Ψ	7
Operating Parameter Q	8

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Modulates	9
Essential Characteristic	10
Changes a lot more	11

None of these are taught by Sweeny.

My 1995 disclosure presents specific test data which was obtained using 5 inch diameter aperture clip #88 with indicator (element 2) SN 2366.

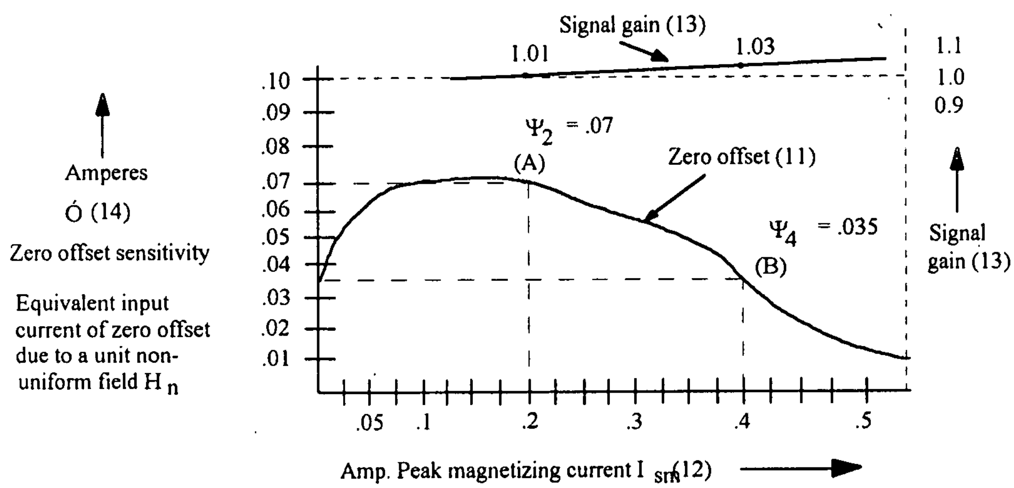
The introduction is DISCOVERY:

DISCOVERY

1995 page 11 Line 11-15

The inventor discovered that the output V of many Swain Meter clamps was a lot less sensitive (1/2 to 1/3 in some sensors) to a change in the intensity of a non-uniform magnetic field H_n when the magnitude of an operating parameter I_{sm} was doubled or tripled. And the sensitivity (gain) to a change in signal input current I stayed constant to within a few percent.

The test data is in figure 4:



1995 Page 57
Figure 4

Fig. 4

Normalized Signal Gain (g) vs. I_{sm}
and
Normalized Zero Offset from H_n vs. I_{sm}
for
Five inch diameter aperture sensor #88.

This specific Essential Characteristic is derived from figure 4.

4-15-03

8.66

Essential Characteristic

1995 Page 11 Line 16-23

Fig. 4 shows the approximate sensitivities for a five inch diameter aperture clip #88. This is an illustration of a sensor having the essential characteristic:

Firstly, the signal gain g (13) sensitivity to signal input I (7) is constant within a few percent as an operating parameter I_{sm} (12) changes from 0.18 A to 0.5 Amp peak; and

Secondly, the zero offset (11) sensitivity to a unit change in intensity of a non-linear magnitude field H_η (8) is reduced to well under half over the same range of I_{sm} (12).

These state numerical results for a specific structure tested using a specified method. For example:

Relationships of Elements of Claim 66 in Figure 4:

In figure 4:

gain g (element 5) changes only 2% as the operating parameter (element 8) changes from .2 to .4 Amp. But sensitivity Ψ (element 7) to interference N (element 6) changes from .7 to .035 over the same range of operating parameter, so the operating parameter modulates (element 9) Ψ, and to a lesser extent said gain g (line 10 of claim 66). The change in Ψ is 2 to one, but the change in g is only 1.02 to one.

The Cited References do not mention these element functions.

The cited references do not show these element functions in claim 66. Nor do they have antecedent teaching even close to claim 66.

Analytic

The general process (method) is put forth on pages 20-23. The basic equation i) is:

$$V_c = V_B - V_A/\eta$$

$$V_c = g_B I + Z_B - \left(\frac{1}{\eta}\right)(g_A I + Z_A)$$

$$V_c = \left(g_B - \frac{g_A}{\eta}\right)I + \left(Z_B - \frac{Z_A}{\eta}\right)$$

By Eq. h) $Z_B = g_B \Psi_B N$; and $Z_A = g_A \Psi_A N$. Then

$$\boxed{\text{Eq. i)}\ V_c = \left(g_B - \frac{g_A}{\eta}\right)I + \left(g_B \Psi_B - \frac{g_A \Psi_A}{\eta}\right)N.}$$

This is a more basic equation, i.e., a general method.

1995 page 22 Line 1-14

The second term is the error due to noise which we want to cancel. Then the coefficient of noise N will be zero if:

4-15-03 ✓

$$g_B \Psi_B = \frac{g_A \Psi_A}{\eta}, \text{ or}$$

$$\frac{1}{\eta} = \frac{g_B}{g_A}\frac{\Psi_B}{\Psi_A}, \text{ and remembering that } \frac{\Psi_B}{\Psi_A} \equiv \beta, \text{ we have}$$

$$\text{Eq. j)} \quad \frac{1}{\eta} = \frac{g_B}{g_A}\beta, \quad \text{or} \quad \eta = \frac{g_A}{\beta g_B}.$$

So the requirement for noise N cancellation is that the sensor be designed so that the divisor factor η is set according to Eq. j), using measured or calibrated characteristics of the sensor as shown in Fig. 6.

Note that if $g_A \doteq g_B$; $\eta = \frac{1}{\beta}$; or $\eta\beta \doteq 1$ is close to the error cancelation requirement.

Calculated output from Element Values

This method calculates the output V_c (element 22 in claim 66) in terms of the input I (element 4), the interference N (element 6), the properties g (element 5) and Ψ (element 7) of the sensor (element 1) in states A (element 27) and B (element 30). Details are in pages 20-23.

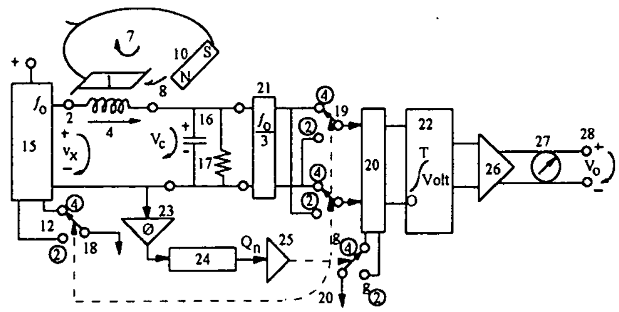
The disclosures of the cited references do not show or infer this general method.

They do not have an analysis to show the result expected.

They do not show elements corresponding to elements in claim 66.

Drawings

Figures 9 and 11 show the implements used with sensor 5" clip #88. Figure 9 follows:



1995, page 62
Figure 9

Fig. 9: A switching implementation of the mathematical relationship shown in Eq. i).

4-15-03 ✓

8.66

Construction

Pages 32-36 provide details for building the implement of figure 9 with 5" sensor #88. Samples from pages 34 and 35 follow.

1995 Page 34 Lines 4-13

In Fig. 9 a counter 24 and switches 18, 19,and 20 are provided to implement the mathematical relation Eq. i), making use of the discovered essential characteristics of the clamp as shown in Fig. 4. The switches are all operated by the gate signal 25. This times the process. A phase shifter 23 and counter 24 are driven by the inverter 15 at frequency f_0. The counter drives the gate differently after $Q_n = 2^n$ cycles of f_0, where n may be as small as 1, but 5 or 6 is more typical.

In this illustrative example, the timing of the transfer from "2" to "4" state and back is controlled by the phase shifter (Ø) 23 and a counter 24. The gate switching is synchronized to the inverter V_X, and delayed by the phase shifter an amount roughly equal to half of a half cycle of V_X. This avoids transients just when current I_s is at a maximum. The counter is set to 2^n (V_X cycles), where this time is long compared to the time constant CR_s 16 and 17.

1995 page 35 Line 8-12

The "2" and "4" states in time intervals A and B alternate, and the integrator 22 averages the output packets of both to give one long term average* output. This is amplified 26 to produce the output V_0 28 for data logging, etc., and driving the output meter 27.*** The user can read the input current I_i 7 and not be troubled by the noise of zero shift error Z due to magnet 10 because it has been largely removed by the above error correction.

The voltage and current waveforms for figure 9 are given on figure 11, page 63.

Antecedent for Elements of Claim 66 on pages 34 and 35.

The elements of claim 66 have antecedent on the parts of pages 34 and 35 above:

on page 35, Operating parameter of magnitude Q (element 8) is the state "2" when $I_{sm} = 0.2$ Amp in time A (element 27); or the state "4" when $I_{sm} = 0.4$ Amp in time ß (element 30)

Output V_c (element 22) has antecedent in figure 9, item 28, V_0.

State means (element 23) has antecedent in figure 9; switches 18, 19, and 20 of page 34.

Input I (element 4) has antecedent in figure 9 and page 35, line 11 (input current I_i 7).

Interference N (element 6) has antecedent in figure 9 and page 35, line 11 (magnet 10).

4-15-02

A large part of said responsiveness to said physical quantity input I (element 38) has antecedent in page 35 line 10-11 (The user can read the input current I_i 7)

A whole lot more accurate (element 39) has antecedent in page 35 line 11 (and not be troubled by the noise of zero shift error Z due to magnet 10)

These elements are not stated or implied in the cited references. Therefore by MPEP 2131, they do not anticipate claim 66.

MPEP 2131

TO ANTICIPATE A CLAIM, THE REFERENCE MUST TEACH EVERY ELEMENT OF THE CLAIM

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). "The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989). The elements must be arranged as required by the claim, but this is not an *ipsissimis verbis* test, i.e. identity of terminology is not required. *In re Bond*, 15 USPQ2d 1566 (Fed. Cir. 1990).

Test Result

1995 Page 36 Line 16-19 When tested with a non-uniform magnetic field H_n from a nearby speaker magnet, the zero offset error was one ampere equivalent input under the previous conditions not using this invention. The noise or zero offset error in the corrected output was generally less than ± 0.1 Amp. equivalent input current. This is a ten to one benefit. The benefit is usually 3 to 20.

Element 39: A whole lot more accurate.

This is antecedent for claim 66, element 39: "a whole lot more accurate".

The cited references do not teach or infer how to reduce the error due to a non-uniform magnetic field H_n from a nearby magnet. No such quantitative results are given.

Sweeny supplemented by the Examiner provides no report of a quantitative and useful result.

Possibly Changing the Signal-to-Noise Ratio (SNR), or

Possibly Having the Essential Characteristic" is not Enough

4-15-03 JJ

The Examiner stated:

Examiner 1-29-03 Page 3, Line 14-17	Applicant has stated in his specification that changing the bias on a saturable core device will change the signal-to-noise ratio. Swain uses the same kind of core material as used in the present application and will thus inherently have the "essential characteristic".

I did not say these things, as explained in another part of this brief.* Nor are they true so that the cited references "necessarily" anticipate claim 66, as required by MPEP 2112.

MPEP 2112 Page 2100-47	EXAMINER MUST PROVIDE RATIONALE OR EVIDENCE TENDING TO SHOW INHERENCY >The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993)(reversed rejection because inherency was based on what would result due to optimization of conditions, not what was necessarily present in the prior art); *In re Oelrich*, 666 F.2d 578, 581–82, 212 USPQ 323, 326 (CCPA 1981).< "In relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art." *Ex parte Levy*, 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990) (emphasis in original)

But if the Examiner's statements were somehow accepted at face value, the cited references still would not anticipate claim 66 because:

Discovery

a) Interference N (element 6) is part of the discovery leading to the invention. The method of claim 66 teaches how to overcome this undesired error producing interference N (element 6), i.e., a strong non-uniform magnetic field H_n. I wrote on page 9:

----

* Section 8.45 Orthogonal modulation is required: p. 63-64; figure 12.
Compare Swain 1970 with Swain 1995: p. 74-75
The structures differ by one to two orders of magnitude.

8-18-03

Page 9
Lines 5-11

The most difficult type of interference noise N to control has been that due to a strong non-uniform magnetic field H_n such as that shown in Fig. 3. A stray magnet, perhaps in a weld in a pipe, a sector of magnetized sheet metal in an automobile near the battery cable, or a magnetized fastener near the sensor can produce a considerable zero offset error Z. When the clamp-on sensor is moved from nearby to really around the conductor carrying the current to be measured, the intensity and direction of the effective non-uniform field H_n changes, and this changes the zero offset Z, and so reduces the accuracy of output V.

MPEP 2141.02 says a patentable invention may be in the discovery.

DISCOVERING SOURCE/CAUSE OF A PROBLEM IS PART OF "AS A WHOLE" INQUIRY

"[A] patentable invention may lie in the discovery of the source of a problem even though the remedy may be obvious once the source of the problem is identified. This is *part* of the 'subject matter as a whole' which should always be considered in determining the obviousness of an invention under 35 U.S.C. § 103." *In re Sponnoble*, 405 F.2d 578, 585, 160 USPQ 237, 243 (CCPA 1969) ...

from prior art *which contains the same solution for a similar problem*." *In re Wiseman*, 596 F.2d 1019, 201 USPQ 658, 661 (CCPA 1979) (emphasis in original).

In *In re Sponnoble*, the claim was directed to a plural compartment mixing vial wherein a center seal plug was placed between two compartments for temporarily isolating a liquid–containing compartment from a solids–containing compartment. The claim differed from the prior art in the selection of butyl rubber with a silicone coating as the plug material instead of natural rubber. The prior art recognized that leakage from the liquid to the solids compartment was a problem, and considered the problem to be a result of moisture passing *around* the center plug because of microscopic fissures inherently present in molded or blown glass. The court found the inventor discovered the cause of moisture transmission was *through* the center plug, and there was no teaching in the prior art which would suggest the necessity of selecting applicant's plug material which was more impervious to liquids than the natural rubber plug of the prior art.

My DISCOVERY statement shows that I discovered both the problem - the non-uniform field H_n, and a solution; A method for causing a change in SNR; use the Essential Characteristic, by changing the operating parameter.

DISCOVERY

1995 Page 11
Line 11-15

The inventor discovered that the output V of many Swain Meter clamps was a lot less sensitive (1/2 to 1/3 in some sensors) to a change in the intensity of a non-uniform magnetic field H_n when the magnitude of an operating parameter I_{sm} was doubled or tripled. And the sensitivity (gain) to a change in signal input current I stayed constant to within a few percent.

The Essential Characteristic is also described.

4-18-03

Ibid

Line 16-23

Essential Characteristic

Fig. 4 shows the approximate sensitivities for a five inch diameter aperture clip #88. This is an illustration of a sensor having the essential characteristic:

Firstly, the signal gain g (13) sensitivity to signal input I (7) is constant within a few percent as an operating parameter I_{sm} (12) changes from 0.18 A to 0.5 Amp peak; and

Secondly, the zero offset (11) sensitivity to a unit change in intensity of a non-linear magnetic field H_n (8) is reduced to well under half over the same range of I_{sm} (12).

The references do not anticipate because they do not teach how to operate.

b) Even if the cited references somehow had the Essential Characteristic (and this is doubtful), they still would not anticipate claim 66, (or claims 32-66) because they do not teach how to operate the sensor to make use of the Essential Characteristic to improve accuracy.

Operate

The Essential Characteristic is not useful unless the sensor is operated so as to improve accuracy (elements 20 and 39 in claim 66). The method in claim 66 is summarized in the 1995 abstract. The "operate" sections of the Abstract provide antecedent for most of the 39 elements in claim 66.

1995 page 52

Line 1-17

(h) Abstract of the Disclosure.

The accuracy of certain sensors is greatly improved by improving their signal to noise ratio (SNR) in the presence of an interfering noise. Sensors were discovered which have a SNR which substantially changes when an operating parameter is selectively modulated to different magnitudes. Some noise can be practically eliminated. In the simplest form, the sensor is operated where it is both stable and close to its best SNR. This is usually faster and less costly, but the noise is never completely eliminated.

Often, the method involves operating the sensor in first one state and then another wherein the operating parameter has conditions where the sensor is stable, reproducible, and reliable, and wherein the SNRs are substantially different. The output of a state is combined with the output of another state in such a way that the noise cancels but a signal remains. Often the output in a state having greater noise is attenuated until it matches the noise content of another state having less noise. Then these outputs are subtracted. The difference is the more accurate error corrected output. In the ideal case, the difference has no noise output because the noise in the output from one state canceled the noise in the output of the other state.

4-18-03 //

However there is good signal in the difference, typically half as large as before subtraction, because the SNR in one state is preferably about double that in another state.

Antecedent for "operate" Elements

Line 5-8 above is antecedent for "operate" claim 66 elements 12-19; error reducing form, fitted, support, drive, hold, Ψ is a lot less, gain g is still good, thus the implement (element 2) is substantially more accurate (element 20).

Line 8-17 above is antecedent for most of "operate" elements 21-38. The method of claim 66, read in the light of the disclosure, teaches how to "operate" the sensor so it is more accurate (element 39).

None of the cited references do this. Therefore they do not anticipate, as stated by MPEP 2131.

MPEP 2131

TO ANTICIPATE A CLAIM, THE REFERENCE MUST TEACH EVERY ELEMENT OF THE CLAIM

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). "The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989). The elements must be arranged as required by the claim, but this is not an *ipsissimis verbis* test, i.e. identity of terminology is not required. *In re Bond*, 15 USPQ2d 1566 (Fed. Cir. 1990).

Comparing claim 66 with the cited references will show that the cited references do not contain each and every element, either expressly, or inherently.

4-18-03 JJ

$\mathcal{L}_1$

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i2

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λ 3

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λ 4

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Generic claims 63-66 should soon be examined on merit. This has not yet been done. They were properly filed over 3 years ago - on 24 March 2000 - but bypassed when the Examiner mistakenly discussed only claim 45 in his action of 25 September 2002 and 29 January 2003.

Details are given, refuting my purported admissions - they would have made no sense. I define the basic concept, show antecedent in the disclosure and the record, and examples of its inclusion in claims 32-66 which should be allowed because elements are not in the cited references.

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λ6

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Contents of Appendix

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Claim 32 (amended)

I Claim:

A method for making an implement with improved accuracy for measurement or control of a physical quantity by canceling out error due to an interfering noise N so as to provide an error corrected output V_C, sensitive to a signal input I, which includes the steps:

find or construct a sensor with an output V which has a signal to noise ratio SNR which changes substantially when the condition of an operating parameter Q is selectively modulated,

provide means whereby said output V of the said sensor in a higher said SNR state due to a condition of said operating parameter Q is combined with said output V of said sensor in a lower said SNR state due to a different said condition of said operating parameter Q, and

adjust said combined so that the said noise N mostly cancels but said sensor continues to have a good gain for said signal input I.

Claim 33

A method as claimed in claim 32, wherein said input I and said noise N are conditioned, or generally change by only a small amount during the time duration of one full operating cycle of change of said condition of said operating parameter Q.

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Claim 34

A method as claimed in claim 32, wherein said sensor comprises at least two said sensors or a composite sensor having at least two sectors, and wherein each one of said two sensors or said two sectors operates full time at a different said condition of said operating parameter Q,

so that there is thereby no need to have a short operating cycle time and no need to condition said input I and said noise N or require that they be generally constant over said one full operating cycle.

Claim 35

A method as claimed in Claim 32 wherein said sensor is a non-contact ammeter which incorporates at least one Hall device associated with a magnetic core SQ.

Claim 36

A method as claimed in Claim 32 wherein said sensor is a non-contact ammeter which incorporates at least one Hall device associated with a magnetic core SQ, and

wherein said operating parameter Q is the magnetic reluctance of said magnetic core SQ.

Claim 37

A method as claimed in claim 32 wherein said sensor is a non-contact ammeter which incorporates a Swain type coupling winding N_S wound on a core SQ.

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Claim 38

A method as claimed in claim 32 wherein said sensor is a non-contact ammeter which incorporates a Swain type sense coupling winding N_S on a core SQ, and wherein said operating parameter Q is the peak current I_{sm} in said sense coupling winding N_S.

Claim 39 (amended)

An implement with a sensor for measurement or control having an output V which changes when a desired signal input called I, changes,

and also wherein said output V of said sensor changes so that it has an error when an interfering noise source called N changes,

said signal I and said noise N are required to be inherently or conditioned to be largely constant in magnitude and direction for a time duration here called T_{A+B},

and means are provided to largely correct said error while preserving said input I at an output of said implement here called V_C, and

said sensor is further chosen or constructed so that it has the essential characteristic that when the condition of an operating parameter Q is changed by a selective modulator, the sensitivity of said output V to said signal I is altered substantially differently from the sensitivity of said output V to said noise N in a manner called selective modulation;

more particularly, in said sensor said output V change per unit signal input I change is here called gain g, i.e.,

$$g \equiv \frac{\delta V}{\delta I}, \text{ and}$$

said output change per unit noise change is here called noise sensitivity Ψ,

defined as the change in said output per unit change in said noise, all divided by said gain, i.e.,

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$$\Psi \equiv \frac{\delta V / \delta N}{g}$$, and

said operating parameter Q has at least two conditions here called M_A and M_B which are provided by means enabling, and

a timing means is provided with at least two states Ⓐ and Ⓑ having a total cycle time equal to or less than said T_{A+B}, and arranged to coordinate the action of said modulator,

means are provided whereby said output V is available as output V_A when in said condition M_A in said state Ⓐ and also said output is available as output V_B when in said condition M_B in said state Ⓑ,

means are provided for combining said output V_A and said output V_B so that said noise N is largely canceled at said implement output V_c, and good gain g remains so that said implement output V_c is well responsive to said input I,

said means for combining constructed to accomplish much the same result as the following example:

means are provided for dividing said output V_A by divisor factor here called η, and

means are provided for subtracting said V_A divided by said η from said V_B to form a difference, which is the error corrected difference V_c, and

also, during said state Ⓐ said gain g has the value g_A, and said noise sensitivity Ψ has the value Ψ_A;

and further, during state Ⓑ; said gain g has the value g_B, and said noise sensitivity Ψ has the value Ψ_B;

the ratio of said g_B divided by said g_A is called G, i.e.,

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$$G = \frac{g_B}{g_A},$$

and we herein use the symbol ß for the ratio of said Ψ_B to said Ψ_A, i.e.,

$$ß = \frac{\Psi_B}{\Psi_A}, \text{ and}$$

for best results we choose or construct said sensor and build said selective modulator conditions M_A and M_B so that said sensor has the essential characteristic that said noise sensitivity ratio ß is substantially less than said gain ratio G, i.e.,

$$ß << G;$$

where an example of a practical case is

$$ß = \frac{1}{2}, \text{ and}$$

$$G = 1.04, \text{ and}$$

where said factor η is the ratio of said V_A before said division to that after said division, and wherein said factor η usually has a value close to $\frac{1}{ß}$, i.e.,

$$\eta ß = 1; \text{ approximately, and}$$

said difference V which is a reduced but still useful component of said signal but much less of said noise because the said noise in said V_B was largely canceled by subtracting said $\frac{1}{\eta}$ part of said noise in said V_A,

so said difference Vc is what is wanted; and output sensitive to said input I but with said noise N largely canceled.

Claim 40

An implement with a sensor as claimed in claim 39 wherein said sensor is a non-contact current sensor.

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Claim 41 (amended)

a method for correcting an error due to an interfering noise N in the output V of a sensor for measuring or controlling a physical quantity such as an electric current, temperature, pressure, etc., by the process here called selective modulation, including but limited to:

said sensor being chosen or manufactured so that it has the essential characteristic defined in the following terms:

said output V changes in response to a change in a desired signal input I and has a gain g which is defined as the ratio of said change in V divided by said change in I, i.e.,

$$g \equiv \frac{\delta V}{\delta I},$$

where said δV represents a partial derivative i.e., a small change in said output V produced by a small change in said I represented by said δI, it being understood that all other variables are held constant, and also

said output V also changes when there is a change in said noise N, i.e., said output V has a sensitivity to said noise N, here called Ψ and defined so that it is referenced to an equivalent of said input I by said gain g, i.e.,

$$\Psi \equiv \frac{\delta V / \delta N}{g}$$

and wherein the signal to noise ratio SNR of said sensor is the inverse of said Ψ, i.e., SNR $\equiv \frac{1}{\Psi}$,

and

said sensor is also chosen or manufactured so that it has an operating parameter here called Q, the condition of which, when altered by selective modulation M, substantially modifies the value of said signal to noise ratio SNR, and

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said method involves finding or constructing said sensor having said essential characteristic within the bounds of practical values or conditions of said selective modulation M so that said error correction is useful, an example being;

said M has values $M_A = 20$ and $M_B = 50$
said g has values $g_A = 10$ and $b_B = 11$
said Ψ has values $\Psi_A = 35$ and $\Psi_B = 14$

Then the ratios of said values are:

$$\frac{M_B}{M_A} = \frac{50}{20}, \quad \frac{g_B}{g_A} = \frac{11}{10}, \quad \frac{\Psi_B}{\Psi_A} = \frac{14}{35},$$
$$= 2.5, \quad = 1.1, \quad = 0.4$$

Said $\frac{\Psi_B}{\Psi_A} = 0.4$ has been found to be useful and practical, and

the said method also involves providing means combining, usually to cancel by subtracting the said output when said selective modulation M has one or more values in a first range, all divided by a divisor factor here called η, from the said output when said M has one or more values in a second range;

where for said error correction the value of said η is usually close to said Ψ_A divided by said Ψ_B, as in the above example, but the value of η is adjusted for best error correction,

$$\eta = \frac{\Psi_A}{\Psi_B}\text{, approximately,}$$
$$= \frac{35}{14}$$
$$= 2.5\text{; and}$$

The result of said combining which may be said subtracting is the desired said error corrected output Vc of said sensor; and

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to be effective the result of said combining should be computed during a time when both said signal input and said noise are essentially constant, or so conditioned, or alternatively,

said combining can be done continuously, with practically no limitation on the duration of said time during which said signal and said noise are constant,

when two said sensors, here called sensor A and sensor B, with outputs V_A and V_B are used simultaneously with the said operating parameters Q set to operate continuously at different conditions M_A and M_B so that said sensor A has said SNR_A, and said sensor B has said SNR_B, said combining which may be said V_A is divided by said η, and said result of said subtracting V_c is made continuously available as said error corrected output.

Claim 42

A method as claimed in claim 41 wherein said sensor is a non-contact current sensor.

Claim 43 (amended)

A method [and process] for constructing [and using] a sensor with reduced error for measurement or control including means:

a core of low magnetic reluctance material, here called SQ,

a coupling sense winding on said core having a number of turns, here called N_S,

an inverter having an output current, here called i_S, and an average said output current here called I_S, and also constructed such that said inverter has an operating parameter which is the peak value in either direction of said current, here called I_{sm},

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a low input impedance means converting the said average value I_s of said inverter current to an output voltage here called V_c,

and said method includes:

[positioning] said core constructed so that it is optionally positioned to be influenced by a conductor carrying a signal current I to be measured,

said position being within the effective range of a magnetic field noise, here called N, causing at least part of an error in the form of a change in zero offset of said output voltage V_c, wherein

the sensitivity of said V_c to said noise N is here called Ψ, and defined as the change in said V_c due to a unit change in said noise N divided by a gain g, i.e.,

$$\Psi \equiv \frac{\delta V_c / \delta N}{g}, \text{ where}$$

said g is defined as the change in said output V_c due to a unit change in said signal current I; i.e.,

$$g \equiv \frac{\delta V_c}{\delta I}, \text{ and}$$

said method also includes series connecting said N_s, said inverter, and said low input impedance means converting;

and adjusting said means, including said N_s and said I_{sm}, so that the change in said gain g is considerably less than the change in said noise sensitivity Ψ, as said noise sensitivity Ψ is reduced from a maximum to a value considerably less than said maximum, said reduced being accomplished by altering the value of said means, especially the number of turns on said winding N_s and the said peak inverter current I_{sm}, said altering being preferably in the direction of a greater value of the product of said N_s and said I_{sm},

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and operating said sensor with said product of said N_s and said I_{sm} set so that said noise sensitivity Ψ is considerably reduced below said maximum,

thereby constructing and operating said sensor with said reduced error in zero offset due to said noise N.

Claim 44

A Swain Meter type non-contact direct current ammeter with improved accuracy for measurement or control, which comprises:

a core, here called SQ, of low magnetic reluctance material,

a coupling sense winding, here called N_s, on said core SQ,

an inverter with power supply, here called X, with output terminals with a current i_s flowing which has an average value I_s, and also a peak value I_{sm} which is an operating parameter, all of said currents flowing in either direction in said output terminals,

a low input impedance means converting said average current I_s to an average output voltage V,

a current carrying conductor carrying a signal input current I, which is to be measured or controlled, positioned so that said current I influences said core SQ, and

said core SQ is within the effective range of an interfering magnetic field noise, here called N, and

said coupling sense winding N_s series connected with said output terminals of said inverter X and said low input impedance means converting,

said operating parameter I_{sm} set to a substantially greater magnitude than the magnitude corresponding to the minimum signal to noise ratio, here called SNR, so that thereby the said

SNR is considerably increased over said minimum, so that said non-contact ammeter has considerably greater accuracy in the presence of said interfering magnetic field noise N.

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Claim 45 amended

An improved Sensor

having an output V responsive to a physical quantity I, and also

responsive to an undesired interference N,

the ratio of

the said responsiveness of the said output V to said physical quantity I

in relation to

the said responsiveness of said output V to said interference N

being defined as the Sensor's signal to noise ratio SNR,

which can be stated in symbolic form:

$$SNR \equiv \frac{\delta V / \delta I}{\delta V / \delta N}, \text{ where}$$

δV is a change in said output V,

δI is a change in said physical quantity I, and

δN is a change in said interference N; and also

said Sensor is constructed to have the Essential Characteristic that the

said signal to noise ratio SNR is

substantially altered by Selective Modulation of an Operating Parameter Q, and

means enabling said Sensor to substantially increase said SNR in at least one of:

a Machine, or independently.

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Claim 46 (amended)

An improved machine having a machine output V_c for at least one of measuring or controlling a physical quantity I,

including a sensor having an output V responsive to said physical quantity I,

and also responsive to an undesired interference N,

the ratio of the said responsiveness of the said output V to said physical quantity I

in relation to

the said responsiveness of said output V to said interference N being

defined as the sensor's signal to noise ratio SNR, which can be restated in symbolic form:

$$SNR \equiv \frac{\delta V / \delta I}{\delta V / \delta N}$$

where δV is a change in said output V;

δI is a change in said physical quantity I;

δN is a change in said interference N; and

also said sensor is at least one of found or constructed to have the essential characteristic that the said signal to noise ratio SNR is substantially altered by Selective Modulation of an Operating Parameter Q; and also

including means enabling the operations of at least one of said sensor and said Operating Parameter Q so that

said machine output V_c is more useful

as judged by <u>substantially increased said SNR, and</u> at least one of the characteristics of said machine, including [but not limited to]:

accuracy,

sensitivity or

speed of response,

per unit[,]

dollar cost,

power consumption,

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volume or

weight.

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Claim 47 (amended)

An improved machine having a machine output V_C for at least one of measuring or controlling a physical quantity I,

including a sensor having an output V responsive to said physical quantity I,

and also responsive to an undesired interference N,

the ratio of the said responsiveness of the said output V to said physical quantity I

in relation to

the said responsiveness of said output V to said interference N being

defined as the sensor's signal to noise ratio, which can be restated in symbolic form:

$$SNR \equiv \frac{\delta V / \delta I}{\delta V / \delta N}$$

where:

δV is a change in said output V;

δI is a change in said physical quantity I;

δN is a change in said interference N; and

also said sensor is at least one of found or constructed to have the Essential Characteristic that the said signal to noise ratio SNR is substantially altered by Selective Modulation of an Operating Parameter Q;

and also including means whereby said output V of said sensor in a higher said SNR state due to a condition of said Operating Parameter Q

is combined with said output V of said sensor in a lower said SNR state due to a different said condition of said Operating Parameter Q,

and also including means enabling at least one of said sensor and said Operating Parameter Q and said combined so that

the said interference N is mostly removed from said machine output V_C but

said machine output V_C has a good said responsiveness to said physical quantity I, so that said machine output V_C is more useful as judged by substantially increased said SNR, and at least one of the characteristics of said machine, including:

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accuracy, sensitivity or speed of response, per unit dollar cost, power consumption, volume or weight.

Claim 48 (amended)

A process for constructing an improved machine having a machine output V_c for at least one of measuring or controlling a physical quantity I by

canceling out an error in said machine output V_c due to an interfering noise N so as to provide an error corrected machine output V_c which is sensitive to said physical quantity I,

which includes at least the steps: find/construct, and provide; described as follows:

at least one of find or construct a sensor with an output V which has a signal to noise ratio SNR which changes substantially when the condition of an Operating Parameter is selectively modulated; and

provide means whereby said sensor output V in a higher said SNR state due to a condition of said Operating Parameter Q is

combined with said sensor output V in a lower said SNR state due to an different said condition of said Operating Parameter Q; and

adjust at least one of said combined, said Operating Parameter Q or said sensor so that the said error due to said noise N mostly cancels at the said machine output V_c, but

said machine output V_c is well responsive to said physical quantity I.

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Claim 49

A process as claimed in claim 48, wherein said physical quantity I and said noise N during the time duration of one full operating cycle of change of said condition of said operating parameter Q are at least one of: changed by only a small amount naturally, or are so conditioned.

Claim 50

A process as claimed in claim 48, wherein said sensor comprises at least one of: at least two said sensors or a composite sensor having at least two sectors, and wherein each one of said two sensors or said two sectors operates full time at a different said condition of said operating parameter Q,

so that there is thereby no need to have a short operating cycle time and no need to condition said physical quantity I and said noise N or require that they be generally constant over said one full operating cycle.

Claim 51

A process as claimed in Claim 48 wherein said sensor is a non-contact ammeter which incorporates at least one Hall device associated with a magnetic core SQ.

Claim 52

A process as claimed in Claim 48 wherein said sensor is a non-contact ammeter which incorporates at least one Hall device associated with a magnetic core SQ, and

wherein said operating parameter Q is the magnetic reluctance of said magnetic core SQ.

Claim 53

A process as claimed in claim 48 wherein said sensor is a non-contact ammeter which incorporates a Swain type sense coupling winding N_S wound on a core SQ.

Claim 54

A process as claimed in claim 48 wherein said sensor is a non-contact ammeter which incorporates a Swain type sense coupling winding N_S on a core SQ, and wherein said operating parameter Q is at least one of the peak current I_{sm} or the number of turns in said sense coupling winding N_S.

Claim 55

An improved machine as claimed in claim 47, wherein:

said physical quantity I and said interference N are required to be inherently or conditioned to be largely constant in magnitude and direction for a time duration here called T_{A+B},

said sensor is at least one of chosen or constructed so that it has the essential characteristic that when the condition of said operating parameter Q is changed by a selective modulator, the sensitivity of said output V to said signal I is altered substantially differently from the sensitivity of said output V to said noise N in a manner called selective modulation;

more particularly, in said sensor said output V change per unit physical quantity I change is here called gain g, i.e.,

$$g \equiv \frac{\delta V}{\delta I} \text{ , and}$$

said output V change per unit said interference change is here called noise sensitivity Ψ,

defined as the change in said output V per unit change in said interference N, all divided by said gain, i.e.,

$$\Psi \equiv \frac{\delta V / \delta N}{g}, \text{ and}$$

said operating parameter Q has at least two conditions here called M_A and M_B which are provided by means enabling, and

a timing means is provided with at least two states Ⓐ and Ⓑ having a total cycle time equal to or less than said T_{A+B}, and arranged to coordinate the action of said modulator,

means are provided whereby said output V is available as output V_A when in said condition M_A in said state Ⓐ and also said output is available as output V_B when in said condition M_B in said state Ⓑ,

said means combined are constructed so as to combine said output V_A and said output V_B so that said interference N is largely canceled at said machine output V_c, and said machine output V_c has a good said responsiveness to said physical quantity I,

at least one of said means for combining and said selective modulator and said Operating Parameter Q constructed to accomplish much the same result as the following example:

said means are constructed for dividing said output V_A by divisor factor here called η, and

said means are constructed for subtracting said V_A divided by said η from said V_B to form a difference, which is the error corrected difference V_c, which becomes the said machine output Vc,

also, during said state Ⓐ said gain g has the value g_A, and said noise sensitivity Ψ has the value Ψ_A; and further,

during state Ⓑ; said gain g has the value g_B, and said noise sensitivity Ψ has the value Ψ_B;

the ratio of said g_B divided by said g_A is called G, i.e.,

$$G = \frac{g_B}{g_A},$$

and we herein use the symbol ß for the ratio of said Ψ_B to said Ψ_A, i.e.,

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$$ß = \frac{\Psi_B}{\Psi_A}, \text{ and}$$

for best results we at least one of choose or construct said sensor and build said selective modulator conditions M_A and M_B so that said sensor has the essential characteristic that said noise sensitivity ratio ß is substantially less than said gain ratio G, i.e.,

$$ß << G;$$

where an example of a practical case is

$$ß = \frac{1}{2}, \text{ and}$$

$$G = 1.04, \text{ and}$$

where said factor η is the ratio of said V_A before said division to that after said division, and

wherein said factor η preferably has a value close to $\frac{1}{ß}$ i.e

$$\eta ß = 1; \text{ approximately, and}$$

said difference V_c comprising a reduced but still useful component of said physical quantity I but much less of said interference N because the said N in said V_B was largely canceled by subtracting said $\frac{1}{\eta}$ part of said N in said V_A,

so said difference V_c is what is wanted; a said machine output V_c responsive to said physical quantity I but with said interference N largely canceled.

Claim 56

A machine with a sensor as claimed in claim 55 wherein said sensor is a non-contact current sensor.

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Claim 57 (amended)

A process for correcting an error due to an interfering noise N in the output V_c of a machine for at least one of measuring or controlling a physical quantity I which is at least one of an electric current, temperature, pressure, etc., by the process here called selective modulation, including but not limited to the steps of providing a sensor having an output V and at least one of choosing or manufacturing said sensor so that it has the essential characteristic defined in the following terms:

said sensor output V changes in response to a change in said desired physical quantity I and has a gain g which is defined as the ratio of said change in V divided by said change in I, i.e.,

$$g \equiv \frac{\delta V}{\delta I},$$

where said δV represents a partial derivative, i.e., a small change in said output V produced by a small change in said I represented by said δI, it being understood that all other variables are held constant, and also,

said output V also changes when there is a change in said noise N, i.e., said output V has a sensitivity to said noise N, here called Ψ and defined so that it is referenced to an equivalent of said input I by said gain g, i.e.,

$$\Psi \equiv \frac{\delta V / \delta N}{g}$$

and wherein the signal to noise ratio SNR of said sensor is the inverse of said Ψ, i.e., $SNR \equiv \frac{1}{\Psi}$,

together with the step of at least one of choosing or manufacturing said sensor so that it has an operating parameter here called Q, the condition of which, when altered by said selective modulation M, substantially modifies the value of said signal to noise ratio SNR, and to cancel said noise

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said process includes at least one of the steps of finding or constructing said sensor having said essential characteristic within the bounds of at least one of practical values or conditions of said selective modulation M so that said error correction is useful, an example being;

said M has values $M_A = 20$ and $M_B = 50$

said g has values $g_A = 10$ and $g_B = 11$

said Ψ has values $\Psi_A = 35$ and $\Psi_B = 14$

Then the ratios of said values are:

$$\frac{M_B}{M_A} = \frac{50}{20}, \quad \frac{g_B}{g_A} = \frac{11}{10}, \quad \frac{\Psi_B}{\Psi_A} = \frac{14}{35},$$
$$= 2.5, \qquad = 1.1, \qquad = 0.4,$$

Said $\frac{\Psi_B}{\Psi_A} = 0.4$ has been found to be useful and practical, a

the said process also involves combining, by at least one of, but not limited to, the steps of subtracting the said output when said selective modulation M has at least one of one or several values in a first range, all divided by a divisor factor here called η, from the said output when said M has at least one of said values in a second range;

where for said error correction the value of said η is preferably close to said Ψ_A divided by said Ψ_B, as in the above example, but the value of η is adjusted for best said error correction,

$$\eta = \frac{\Psi_A}{\Psi_B}, \text{ approximately}$$
$$= \frac{35}{14}$$
$$= 2.5; \text{ and}$$

the result of said combining which may be said subtracting is the desired said error corrected output V_c of said machine, and at least one of the steps of: obtaining or conditioning: obtaining the result of said combining as computed during a time when both said physical quantity I and said noise N are essentially constant; or conditioning both said I and said N so that they are at least one of held essentially constant during said combining; or said combining is done continuously,

with practically no limitation on the duration of said time during which said signal and said noise are constant; and in the said step of said continuous combining using two said sensors, here called sensor A and sensor B, with outputs V_A and V_B, - used simultaneously with the said operating parameters Q set to operate said continuously at different conditions said M_A and M_B so that said sensor A has said SNR_A, and said sensor B has said SNR_B, and when said combining is said V_A divided by said η, and said result of said subtracting V_c is made continuously available as said error corrected machine output V_c.

Claim 58

A process as claimed in claim 57 wherein said sensor is a non-contact current sensor.

Claim 59 (amended)

A process for constructing a sensor with reduced error for at least one of measurement or control including means:

a core of low magnetic reluctance material, here called SQ,

a coupling sense winding on said core having a number of turns, here called N_s,

an inverter having an output current, here called i_s, and an average said output current here called I_s, and also constructed such that said inverter has an operating parameter which is the peak value in either direction of said current, here called I_{sm},

a low input impedance means converting the said average value I_s of said inverter current to an output voltage here called V_c,

and said process includes:

means positioning said core so that it is influenced by a conductor carrying a signal current I to be measured,

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said position being within the effective range of a magnetic field noise, here called N, causing at least part of an error in the form of a change in zero offset of said output voltage V_c, wherein the sensitivity of said V_c to said noise N is here called Ψ, and defined as the change in said V_c due to a unit change in said noise N divided by a gain g, i.e.,

$$\Psi \equiv \frac{\delta V_c / \delta N}{g}, \text{ where}$$

said g is defined as the change in said output V_c due to a unit change in said signal current I; i.e.,

$$g \equiv \frac{\delta V_c}{\delta I}, \text{ and}$$

said process also includes series connecting said N_s, said inverter, and said low input impedance means converting;

and constructing said means, including at least one of: said N_s and said I_{sm}, so that the change in said gain g is considerably less than the change in said noise sensitivity Ψ, as said noise sensitivity Ψ is reduced from a maximum to a value considerably less than said maximum, said reduced being accomplished by altering the value of said means, including at least one of: the number of turns N_s on said winding or the said peak inverter current I_{sm}, said altering being preferably in the direction of a greater value of the product of said N_s and said I_{sm},

and operating said sensor with said product of said N_s and said I_{sm} set so that said noise sensitivity Ψ is considerably reduced below said maximum,

thereby constructing and operating said sensor with said reduced error in zero offset due to said noise N.

Claim 60 (amended)

A Swain Meter type non-contact direct current ammeter sensor with improved accuracy which includes:

a core, here called SQ, of low magnetic reluctance material,

a coupling sense winding, here called N_s, on said core SQ,

an inverter with power supply, here called X, with output terminals having a current i_s flowing which has an average value I_s, and also a peak value I_{sm} which is an operating parameter Q, all of said currents capable of flowing in either direction in said output terminals,

a low input impedance means converting said average current I_s to an average output voltage V,

a current carrying conductor carrying a signal input current I, positioned so that said current I influences said core SQ, and

said core SQ is within the effective range of an interfering magnetic field noise, here called N, and

said coupling sense winding N_s series connected with said output terminals of said inverter X and said low input impedance means converting,

said operating parameter I_{sm} set to a greater magnitude than the magnitude corresponding to the minimum signal to noise ratio, here called SNR, so that thereby the said SNR is considerably increased over said minimum, so that said non-contact ammeter has considerably greater accuracy in the presence of said interfering magnetic field noise N.

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Claim 61 (amended)

An improved Non-contact Current Sensor

having an output V responsive to a signal current I, and also

responsive to a magnetic field noise N,

the ratio of

the said responsiveness of the said output V to said signal current I

in relation to

the said responsiveness of said output V to said magnetic field noise N

being defined as the Sensor's signal to noise ratio SNR,

which can be stated in symbolic form:

$$SNR \equiv \frac{\delta V / \delta I}{\delta V / \delta N}, \text{ where}$$

δV is a change in said output V,

δI is a change in said signal current I, and

δN is a change in said magnetic field noise N; and also

said Sensor is constructed to have the Essential Characteristic that the

said signal to noise ratio SNR is

substantially altered by Selective Modulation of an Operating Parameter Q, and

means enabling said Non-Contact Current Sensor to substantially increase said SNR in at least one of:

a Machine, or independently.

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Claim 62 (amended)

An improved Swain type non-contact direct current Sensor

having an output V responsive to a direct current signal I, and also

responsive to an interfering magnetic field noise N,

the ratio of

the said responsiveness of the said output V to said direct current signal I

in relation to

the said responsiveness of said output V to said interfering magnetic field noise N

being defined as the Sensor's signal to noise ratio SNR,

which can be stated in symbolic form:

$$SNR \equiv \frac{\delta V / \delta I}{\delta V / \delta N}, \text{ where}$$

δV is a change in said output V,

δI is a change in said direct current signal I, and

δN is a change in said interfering magnetic field noise N: and also

said Sensor is constructed to have the Essential Characteristic that the said signal to noise ratio SNR is

substantially altered by Selective Modulation of an Operating Parameter I_{sm}, and

means enabling said Swain type non-contact direct current Sensor to substantially increase said SNR in at least one of:

a Machine, or independently.

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Claim 63

I claim a more accurate machine for at least one of measuring or controlling an input physical quantity I which produces a response at said machine's output V_C which is also responsive to an undesired error producing interference N;

said machine including a sensor which has an
output V responsive to said input I, and also
said output V is responsive to said error producing interference N; and also

said sensor has an operating parameter having magnitude Q;

and in addition said sensor has the Essential Characteristic that
a change in the said magnitude Q of said operating parameter causes a considerable change in the responsiveness of said output V to said interference N

relative to the responsiveness of said output V to said input I, and

said machine also includes support means
to thereby at least one of considerably reduce or practically cancel
the response of said machine output V_C to said interference N
while maintaining a good response to said input quantity I,
thereby considerably improving said machine's accuracy.

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Claim 64

I claim a method for making a more accurate implement for at least one of measurement or control including the steps:

Construct a port for desired input signal I, which of necessity makes a port for undesired error producing interference N,
construct a port for said implement's output V_C,
acquire an Essential Characteristic type sensor having an output V responsive to said desired input signal I, and also
responsive to said undesired error producing interference N, and further
having an operating parameter of magnitude Q;

show that said Essential Characteristic type sensor has a useful said Essential Characteristic evidenced by
a signal to noise ratio SNR of said sensor observed to change a lot when the
said magnitude Q of said operating parameter is modulated over a practical range;

provide said implement equipped to:
support said sensor and at least one of:

largely cancel said interference N but retain a good signal I at said output V_C by
suitably modulating said magnitude Q,
operating on said sensor output V and
coupling the result to said output V_C of said implement in a manner such that
a reduced form of the said sensor output V in a lower said SNR state is
combined with said sensor output V in a higher said SNR state so that
said interference N largely cancels;
or;
considerably reduce said undesired interference N relative to said desired signal I at said output V_C by
holding said magnitude Q in a higher said SNR state and
coupling said sensor output V to said implement output V_C.

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Claim 65

I claim a more accurate sensor with implement for at least one of measurement or control,

including said sensor having a strong Essential Characteristic, and also an output V responsive to a physical quantity input I, the gain g given by

$$g \equiv \frac{\delta V}{\delta I}, \text{ and}$$

said output V also responsive to an undesired error producing interference N,

the sensitivity Ψ being

$$\Psi \equiv \frac{\delta V}{\delta N}, \text{ and}$$

said sensor also having an operating parameter of magnitude Q which modulates said Ψ, and to a lesser extent said g;

said sensor having been shown by at least one of calibration, proven manufacturing process, or other demonstration to have said strong said Essential Characteristic, i.e., the said sensitivity Ψ changes a lot more than said gain g when said magnitude Q is driven over a practical range of values; and

also including at least one of:

an error reduction form of said implement, fitted to support said sensor, and

fitted to drive said magnitude Q and hold it at a constant value, which is predetermined to cause said sensor to operate with said interference sensitivity Ψ a lot less than was heretofore customary, while said gain g is still good,

thereby making said sensor with said implement substantially more accurate than comparable transducers for said physical quantity I in the presence of said interference N;

or;

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an error correction form of said implement having an output V_c, and also fitted to support said sensor, and further equipped with state means:

driving said magnitude Q,

dividing the said output V, and

combining the said output V,

and said combining is coupled to said implement output V_c; and in addition, said state means are constructed so there is at least one state "A" wherein said means drive said magnitude Q to produce a large said sensitivity Ψ with good said gain g, and

also wherein said sensor output V is largely said divided and made available for said combining;

and moreover, said state means are constructed so that there is also at least one state "ß" wherein said means drive said magnitude Q to produce a small said sensitivity Ψ with good said gain g, and also said sensor output V is but slightly said divided and made available for said combining; and furthermore;

said error correction form of said implement is constructed so that said large Ψ of said state "A" is at least one of said divided or said combined so that the result is about equal to and opposite from the result in said state "ß" wherein said small Ψ was said slightly divided, and

thereby the said Ψ's approximately cancel in said combiner, so that the said error producing interference N is mostly removed from said output V_c; and not withstanding,

there is remaining at said V_c a large part of said responsiveness to said physical quantity input I; so that thereby said sensor with implement is a whole lot more accurate than comparable transducers for said physical quantity input I in the presence of said interference N.

Claim 66

I claim a method for making a more accurate sensor with implement for at least one of measurement or control, made in steps:

obtain a said sensor having an output V responsive to a physical quantity input I, the gain g given by

$$g \equiv \frac{\delta V}{\delta I}, \text{ and}$$

said output V is also responsive to an undesired error producing interference N, the sensitivity Ψ being

$$\Psi \equiv \frac{\delta V}{\delta N}, \text{ and}$$

in addition, said sensor has an operating parameter of magnitude Q which modulates said Ψ, and to a lesser extent said gain g;

at least one of calibrate, or make by a proven process, or otherwise assure that said sensor has a strong Essential Characteristic evidenced by observing that said Sensitivity Ψ changes a lot more than said gain g when said magnitude Q is driven over a practical range of values;

and at least one of:

provide an error reducing form of said implement, fitted to support said sensor, and

also fitted to drive said magnitude Q and hold it at a constant value, and by at least one of measurement or a proven process, set said magnitude Q at a value corresponding to a said sensitivity Ψ which is a lot less than heretofore while said gain g is still good,
thus making said sensor with implement substantially more accurate than comparable transducers for said input I in the presence of said interference N;
or;

provide an error correction form of said implement having an output V_C, and
also fitted to support said sensor, and

further equipped with state means

driving said magnitude Q,

dividing the said output V, and

combining the said output V, and

wherein said combining is coupled to said implement output V_c;

construct the said state means so that there is at least one state "A" wherein

said means drive said magnitude Q to produce a large said sensitivity Ψ with good said gain g, and also said sensor output V is largely said divided and made available for said combining;

further construct said state means so that there is also at least one state "ß" wherein

said means drive said magnitude Q to produce a small said sensitivity Ψ with good said gain g, and
also said sensor output V is but slightly said divided and made available for said combining;

to get said error correction, at least one of:

set by a proven process, or adjust at least one of a said means dividing or said means combining so that

the said largely divided said large Ψ of said state "A" is about equal to and opposite from the said but slightly divided said small Ψ of said state "ß", and

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thereby the said Ψ's approximately cancel in said combiner so that the said error producing interference N is mostly removed from said output V_c; and

not withstanding there is remaining at said V_c a large part of said responsiveness to said physical quantity input I;

so that thereby said sensor with implement is a whole lot more accurate than comparable transducers for said physical quantity input I in the presence of said interference N.

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